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Vol. IX. November 26, 1909 No. 1.

SUBJECT: "THE SIDE AND CENTRE BEARINGS OF A CAR."

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Testimony From the Actual Users. (2*)

From time to time we have published statements regarding the merits of the "Modern Boiler Tube," i. e., the steel tube.

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At the 1909 Convention of the International Master Boiler Makers' Association held in Louisville, Ky., there was a discussion of the report of the Committee appointed to investigate the respective merits of steel vs. iron Boiler Flues, and we quote from the published proceedings the remarks of the General Foreman of a large Western Railroad:

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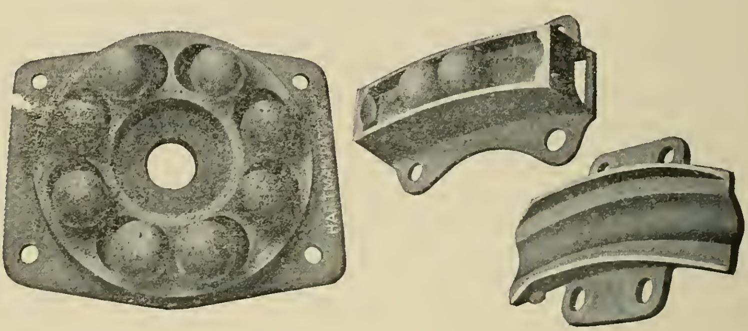

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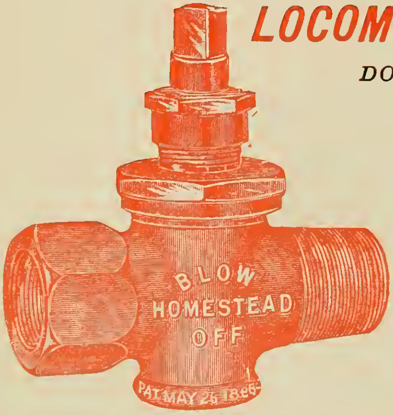

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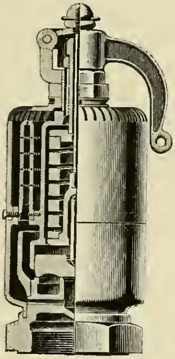

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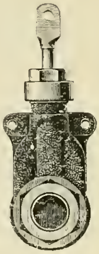

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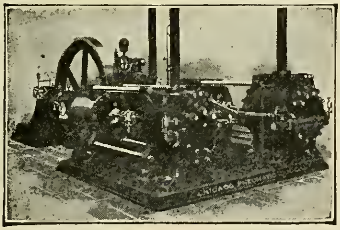

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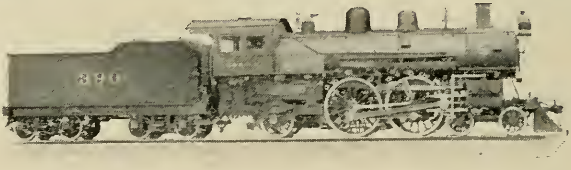

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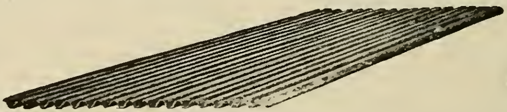

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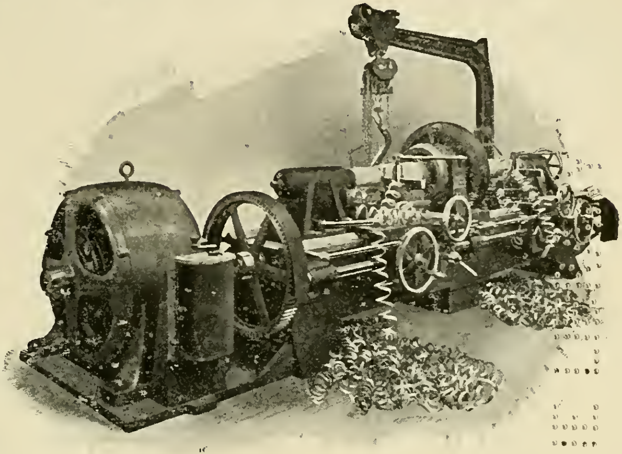

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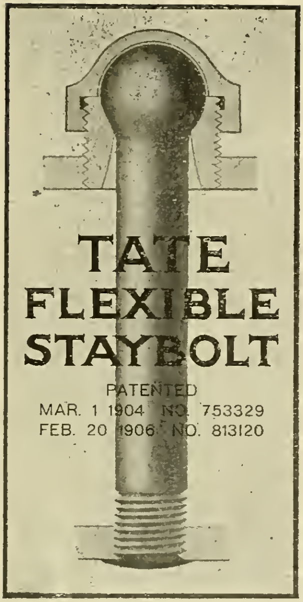

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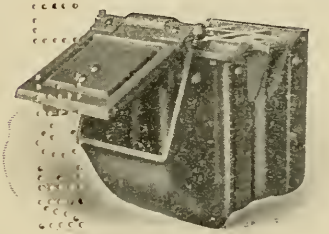

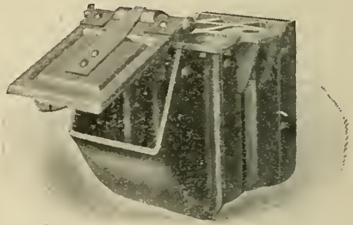

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Vol. IX.
No. 1.

Pittsburgh, Pa., November 26, 1909.

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING, NOVEMBER 26th, 1909.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

278808

The following gentlemen registered:

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Norton, C. L.
Prager, A. A.
Ramsdell, T. M.
Robinson, S. R.
Ryder, G. E.
Rys, C. F. W.
Salsgiver, M.
Schaefer, Frederic
Schaffer, R. H.
Schultz, Geo. H.
Shipe, Warren E.
Smith, R. H.
Smith, Sion B.
Summers, J. M.
Wilson, N. V. F.
Woods, Edwin S.

The reading of the minutes of the last meeting was dispensed with, the Proceedings having been printed.

The Secretary read the following list of applications for membership:

Bailey, J. H., General Foreman, Fifty-sixth Street Plant, The McConway & Torley Co., Pittsburgh, Pa. Proposed by John Pfeil.

Binns, J. Y., Special Agent, Monongahela R. R. Co., Brownsville, Pa. Proposed by D. H. Kinter.

Blazier, Bernard H., Chemist, The McConway & Torley Co., Forty-eighth Street and A. V. Ry., Pittsburgh, Pa. Proposed by John Pfeil.

Boyd, Oliver, Assistant Purchasing Agent, Union Switch & Signal Co., 7926 Tioga Street, Pittsburgh, Pa. Proposed by W. W. Young.

Cochran, Chas. C., Chief Clerk to General Manager, Pressed Steel Car Co., Farmers Bank Building, Pittsburgh, Pa. Proposed by J. B. Rider.

Crehan, J. H., Assistant to President, Gilmore & Pittsburgh R. R. Co., Machesney Building, Pittsburgh, Pa. Proposed by J. W. Henderson.

Criswell, A. B., Inspector, Baltimore & Ohio R. R., Pittsburgh, Pa. Proposed by J. B. Bishop.

Davison, N. C., Equipment Engineer, Keenan Building, Pittsburgh, Pa. Proposed by John Pfeil.

Edmunds, Frank W., Sales Agent, The Dressel Railway Lamp Works, 3860-3878 Park Avenue, New York, N. Y. Proposed by C. W. Alleman.

Evans, F. D., Chief Clerk Treasury Department, Pressed Steel Car Co., Farmers Bank Building, Pittsburgh, Pa. Proposed by H. E. Swartz.

Ferguson, D. E., Purchasing Agent, H. K. Porter Co., Forty-ninth Street, Pittsburgh, Pa. Proposed by John Pfeil.

Gibson, Frank, Chief Clerk to Superintendent, Union R. R., 516 South Avenue, Wilkinsburg, Pa. Proposed by F. R. McFeatters.

Gibson, Wm. S., Assistant Engineer M. of W., Union R. R. Co., 1110 Union Avenue, McKeesport, Pa. Proposed by F. R. McFeatters.

Good, H. J., Traveling Car Inspector, Union R. R., Unity, Pa. Proposed by A. F. Coulter.

Gridley, Sidney D., Chainman, Pennsylvania R. R. Co., Gallitzin, Pa. Proposed by C. W. Alleman.

Hill, Chas. E., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by J. D. White.

Imhoff, H. B., General Manager Sales, Keystone Steel Foundry Co., Frick Building, Pittsburgh, Pa. Proposed by H. V. Porter.

Jackson, W. V. C., Manager American Directory Co., Renshaw Building, Pittsburgh, Pa. Proposed by John Pfeil.

Johnson, I. S., Resident Inspector, Pennsylvania R. R. Test Department, Union Station, Pittsburgh, Pa. Proposed by Wm. C. Shuck.

Leonard, E. J., Traveling Inspector, United Coal Co., Bank for

Savings Building, Pittsburgh, Pa. Proposed by Samuel Lynn.

Lockwood, B. D., Assistant Chief Engineer, Pressed Steel Car Co., 444 Dawson Avenue, Bellevue, Pa. Proposed by Chas. A. Lindstrom.

Mason, F. N., Secretary and Treasurer, Universal Flexible Packing Co., 3109 Penn Avenue, Pittsburgh, Pa. Proposed by Howard A. Pratt.

More, F. E., Motive Power Inspector, Pennsylvania Lines, Fort Wayne, Ind. Proposed by G. P. Sweeley.

McCloskey, J. C., Clerk, Union R. R. Co., Port Perry, Pa. Proposed by F. R. McFeatters.

McGregor, J. E., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by J. D. White.

McKeen, J. W., Rep. Davis Expansion Boring Tool Co., 7620 Tioga Street, Pittsburgh, Pa. Proposed by F. M. McNulty.

Pechstein, Albert J. G., Electrician, The McConway & Torley Co., Forty-eighth Street and A. V. Ry., Pittsburgh, Pa. Proposed by John Pfeil.

Ralston, J. S., President, Ralston Steel Car Co., First National Bank Building, Columbus, Ohio. Proposed by C. S. Rea.

Robinson, S. R., Care Duquesne Steel Foundry Co., Coraopolis, Pa. Proposed by A. D. Smith.

Roett, J. D., Chief Draftsman, Union Switch & Signal Co., 7914 St. Lawrence Avenue, Swissvale, Pa. Proposed by W. W. Young.

Rourke, M. A., President, The Iron City Brass Foundry Co., Lyceum Building, Pittsburgh, Pa. Proposed by John Pfeil.

Rowand, Will H., Special Representative, W. W. Lawrence & Co. Pittsburgh, Pa. Proposed by H. V. Porter.

Rupp, R. D., Stenographer, Pennsylvania R. R. Co., Union Station, Pittsburgh, Pa. Proposed by J. B. Anderson.

Sampson, Jas. M., Metallurgist, The McConway & Torley Co., 5141 Woodlawn Avenue, Pittsburgh, Pa. Proposed by John Pfeil.

Schaffer, R. H., Clerk, Office General Superintendent, Pennsylvania R. R. Co., Union Station, Pittsburgh, Pa. Proposed by R. H. Mackenzie.

Schaub, Theo. J., Jr., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by J. D. White.

Schultz, Geo. H., Rep. Purchasing Department, Pennsylvania R. R., Union Station, Pittsburgh, Pa. Proposed by Wm. C. Shuck.

Shields, W. W., Salesman, C. Trautman Co., 1801 Carson Street, Pittsburgh, Pa. Proposed by John Pfeil.

Shipe, Warren E., Clerk, Office Superintendent Motive Power, Pennsylvania R. R. Co., Union Station, Pittsburgh, Pa. Proposed by M. J. Hepburn.

Sims, David H., Assistant Yard Master, P. & L. E. R. R., Lock Box 26, Pittock, Pa. Proposed by F. H. Stark.

Stephenson, F. M., Treasurer, Union Sheet & Tin Plate Co., Farmers Bank Building, Pittsburgh, Pa. Proposed by John Pfeil.

Williams, W. W., Master Mechanic, Crucible Steel Co. of America, Thirtieth Street, Pittsburgh, Pa. Proposed by A. W. Crouch.

Wilson, Harry, Wholesale Lumber, Bessemer Building, Pittsburgh, Pa. Proposed by John Pfeil.

Wood, Ralph C., Draftsman, City of Pittsburgh, 225 Forty-fourth Street, Pittsburgh, Pa. Proposed by John Pfeil.

PRESIDENT: These names will be submitted to the Executive Committee, and if by them acted upon favorably, as I trust they will be, the gentlemen will become members.

I am sorry to have to announce the death of two members, Mr. George T. Barnsley, who has been a member for a number of years and also an officer, who died very suddenly on October 23rd, the day following our last meeting, and Mr. G. H. Davis, General Foreman Car Department, Wabash-Pittsburgh Terminal Railroad, who died early Thursday morning, November 25th.

I will appoint as committees to prepare suitable memorial resolutions, upon the death of Mr. Barnsley, Messrs. D. M. Howe, J. W. Henderson and F. M. McNulty, and for Mr. Davis, Messrs. H. W. McMaster, F. H. Stark and Samuel Lynn.

If there is no further business to come before the meeting, we will listen to the reading of the paper of the evening by Mr. A. Stucki, on "The Side and Center Bearings of a Car."

THE SIDE AND CENTRE BEARINGS OF A CAR.

BY MR. A. STUCKI, ENGINEER, PITTSBURGH.

Excepting the small electric equipment, all cars in this country are provided with trucks. This enables them to pass any curve regardless of their length and wheel base, provided care is taken that nothing limits the swivelling motion of the truck while passing the curve.

Centre Plate.

The centre for such a motion is formed by the king pin. But since the load is also supported at this point, a set of centre plates is used. In order to protect the king pin from shear, these centre plates are usually provided with interlocking flanges, hence the functions of a centre plate are twofold, i. e., to form a fulcrum point for the truck and to form a good support for the load.

It is a comparatively easy matter to get a fulcrum point, since the centre plate and the king pin assist each other and no trouble is experienced in this direction, even if the flanges are comparatively low.

To support the load properly is a much harder task. It will be remembered that in the early part of the 90s the diameter was reduced from 12″ to 8″. Things went well until the 100,000 lb. cars came into general use. Then it soon became evident that in order to carry such tremendous loads successfully, i. e., safely and without excessive wear, a larger bearing surface had to be used and the original 12″ diameter was restored. This occurred about seven or eight years ago and the experience since has demonstrated that the change from an 8″ to a 12″ centre plate was the proper move. At the same time the use of soft material, such as malleable iron and pressed steel, has more and more been abandoned, so that today a cast steel 12″ centre plate is the acknowledged standard.

What makes the conditions for the centre plates so exceedingly severe is the fact that not only the swivelling motion of the trucks helps to grind the plates, but that, on the contrary, they are constantly exposed to vibrations and jars and every low rail joint and every impulse in the train will help in this destructive action.

Besides that the cars will swing laterally and in doing so will reduce the bearing surface to a small fraction of the original. This must be very hard on the centre plates, while it lasts, but fortunately it only takes place part of the time. A spherical centre plate would overcome this undesirable feature. There we have always a full bearing surface, but while running on a straight track there would be nothing to stay the car except we would adjust the side bearings so close, so that they actually touch each other. These conditions now exist on most the passenger cars.

On the freight equipment the variations in the height of the bolsters are more pronounced and undoubtedly the best practice is to use flat centre plates and adjust the side bearings as close as possible without, however, allowing the ordinary side bearings to become solid on both sides.

On street wagons the centre plate is usually enlarged so as to stay the vehicle sufficiently. On railroad cars this cannot be done, as it would lead to dimensions and proportions entirely out of question and, therefore, side bearings are always used for this purpose.

Side Bearing Clearance.

It is quite natural that the closer we adjust the mating bearings the steadier riding car we have. On passenger cars, as already mentioned, and on traction vehicles the bearings are usually made to just clear each other without allowing any space. This improves the riding qualities very much and it will preserve the passengers from being rocked in pendulum fashion, receiving at each reversal of the motion a sharp impact not unlike that in a boat during a gale.

Such a close adjustment is possible, since the passenger cars are often inspected and since they have mostly steel bolsters, well fitted, which renders them relatively stiff.

Even a very small movement at the side bearings means a comparatively large movement near the top of the car and to offset also such a possibility most of the six-wheel passenger trucks have their side bearings located ouside of the wheel pieces, so as to work on a larger lever arm. All this shows that a steady riding car without sudden lateral blows is desirable.

Besides the discomfort of the passengers these blows are also hard on the car and truck, and especially in freight car service this forms an important item. Every time the side bearings close, it amounts to a hammer blow. This is first transmitted to both the bolsters and from there upward into the whole car. In the downward direction it first strikes the springs and what is not absorbed thereby goes on to the arch bars, axles and wheels.

The larger the space between the side bearings the larger the blow when the side bearings meet, and the larger the pressure on the one side while they stay closed. One of our most experienced railroad officials had a good deal of trouble on account of tenders derailing, and in looking carefully into the matter found the side bearing clearances excessive, causing the pressure between the side bearings to be abnormally great, gripping the truck too tight, so that it was easier for the wheels to climb the rail than to force the truck around the curve. The trouble was overcome by reducing the side bearing clearances.

Now and then you hear expressions such as, "The best side bearing is a goodly air space," or others similar in meaning. This is misleading, because whenever the car tilts it tilts until it hits the side bearing, and no matter how large the air space was originally there is none left, but the blow is always that much greater.

In some specific cases a close adjustment of side bearings is even more essential than in ordinary freight cars, for instance, on tenders and tank cars it prevents the water and oil from undue swaying, in refrigerator cars it protects the meat against excessive bumps and bruises, on stock cars it makes the journey less tiresome for the stock and less expensive for the drover and shipper. In fact, the smoother riding the car the better the condition of horses and cattle at destination.

Unfortunately we cannot always do as we would like to. All the bolsters will deflect more or less under load, hence the clearance at the side bearing is more with an empty car than with a loaded one. With the old wooden constructions this was and is yet a serious item, and ¾" per side and more is being allowed, so as to be sure that at no time the bolster would deflect enough to let the side bearings become solid on each side of the centre plate. This would be disastrous and would lock the truck as though it was built solid with the car.

The author has about three hundred feet of track with a box car, all ⅛ size. About two hundred feet are bent to a radius of one hundred feet and the remaining one hundred feet are left straight. From the point where the curve and tangent meet the track ascends in both directions. The car is equipped with various side bearings in such a way that any one can be quickly applied. By dropping the car down the straight incline, it stores up a certain amount of energy which will be absorbed again by ascending the curve. Whenever two plain side bearings were allowed to touch on both sides of the centre plate the car was sure to derail.

With steel bolsters we are very much better off, knowing that they deflect much less, and in accordance with action of the M. C. B. Association taken some years ago it is considered safe to have ¼" per side, while on the other hand it was decided not to go above 5-16, so as not to get too much lateral motion.

This question has also enjoyed a good deal of attention from individual parties, judging from the many patents taken out for adjustable side bearings. These were principally constructed so that by taking up another notch or tightening up a bolt, the side bearing could be increased or decreased in thickness, but the additional complications of such devices undoubtedly were against their introduction, at any rate they did not meet with favor. The nearest approach to this principle is a truck side bearing which fits loosely in a socket and which is supported by a wooden block in the bottom of the socket. This block can be made of the required thickness, thus making the side bearings actually adjustable in height. This form of side bearing is successfully used on several roads.

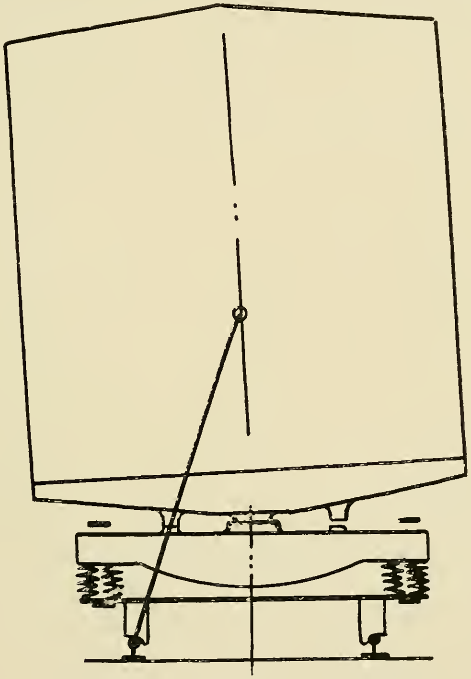


FIG. 1

Spread of the Side Bearings.

Another question often discussed is the spread of the side bearings. Most of them are located 30″ from the centre, a good many 25″ and others as much as 48″. In this last case they are located ouside of the arch bars or wheel pieces. The reason for spreading them as far as possible has already been mentioned above, namely, to reduce the rolling of the car; but there are just as good reasons to keep them as near the centre as possible in order to reduce the friction against swivelling the truck, and we are again confronted by the same problem, to get a steady riding car and a freely swivelling truck.

However, the correct spread of the side bearing is not a matter of mere preference or individual judgment; it is rigidly defined by the centre of gravity of a car.

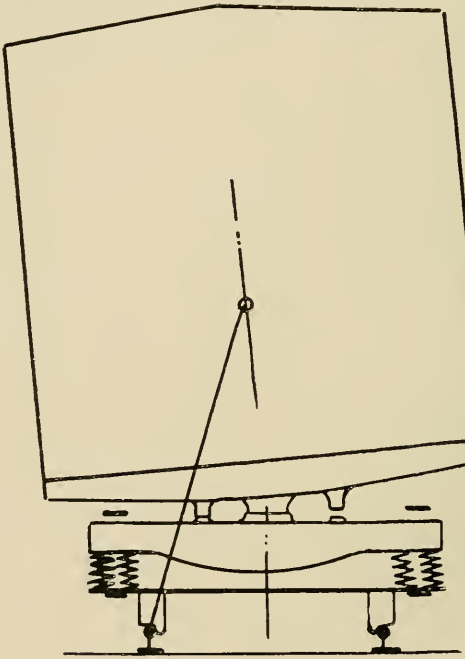


FIG. 2

Supposing a car with a superimposed load in passing a sharp curve at a high speed, is just on the point of tilting on the rail, and if the side bearing is in line between the rail and centre of gravity (See Fig. 1), the car with its load and truck will tilt as a whole.

Should the side bearings be located inside this line (See Fig. 2), it is clear that the body would have tilted on it sooner; in other words, the stability of the car towards tilting is not as great as in Fig. 1.

Reversing the case and locating the side bearings outside the line in question (See Fig. 3), the stability against tilting is a maximum, the same as in Fig. 1, but new conditions arise which are detrimental in other directions. For instance, a stiff car in passing a very uneven track may cause the load to bear exclusively upon one side bearing and, the outside wheel forming a fulcrum, cause the inside wheel to climb the rail. This has happened in actual service more than once.

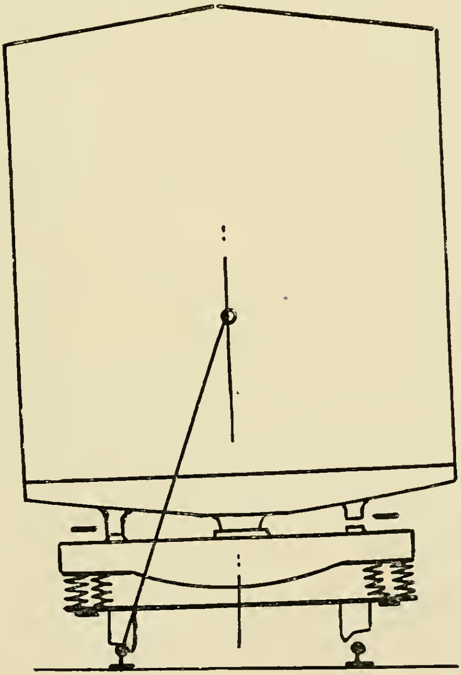


FIG. 3

The reason passenger trucks with outside bearings do not prove out what has just now been said, is that the cars are long and flexible, and that they have a large motion of springs, using equalizer and bolster springs in tandem.

In case of a flat or gondola car with an ordinary load, i. e., with a lower centre of gravity, it is self-evident that we could move the side bearings inward, but it is equally self-evident that we should provide for the worst cases.

For this reason a one-sided load must be considered, which naturally calls for a greater spread than the central loads above mentioned, but the method of determining the correct location is just the same, and the whole question resolves itself into one of loading.

Suggestions have been made not very long ago to determine the correct location by having a car loaded with wheels, and to run it at different speeds. This would be an unfortunate undertaking. In the first place, the central load suggested would never show the real facts, and if one-sided loads would be used we could not tell anything until the train was ditched, but who could tell then whether the car tilted on the side bearing or the car and truck tilted on the rail? Anyhow, nobody could afford to upset a train to find out something which natural laws already define.

The question of uniform taper of the body bolster at the bottom has received some attention, but as yet no definite action has been taken. A glance at any car builder's side bearing print will disclose from possibly 20 to 100 cases, while one could answer just as well. These patterns cost money and their storage is no easy task. Not only that, but it means that at interchange points a number of castings must be kept in stock, instead of one. Besides this, it is plain that such a simplification would also facilitate the manufacture of the body bolsters, especially when patterns or dies are used, and it is to be hoped that the standardizing of this taper will soon receive the attention it deserves.

Advantages of Anti-Friction Side Bearings.

In order to obtain a steady riding car without hampering the free swivelling of the trucks, a good many anti-friction side bearings have been tried, and by comparing the results with those of the plain side bearings it was soon discovered that the advantages were very marked and numerous.

It was found that with such a device the clearance can be reduced to almost nothing, thereby doing away with excessive rolling of the car and yet leaving the truck entirely free to swivel. But what appeals possibly more directly to a railroad official is the fact that the flange wear, the bitter enemy of a car wheel, is greatly reduced.

So far, I find that with plain side bearings from 35% all the way up to 70% of the wheels removed from service are abandoned on account of worn flanges. The smaller figures emanate from roads who are fortunate enough to have comparatively straight tracks and run most of their cars at home, while the higher figures come from roads where curves are frequent.

The Pittsburgh & Lake Erie R. R. Co., with their Superintendent of Motive Power, Mr. L. H. Turner, is unquestionably the pioneer in this field. The larger proportions of their rolling stock is equipped with anti-friction side and centre bearings and their percentage of worn flanges has been found reduced from 39.2 to 2.1 per cent thereby. About 6,000 of their own cars with plain bearings, 8,000 of their own cars with anti-friction bearings, and 8,000 foreign cars were watched for a period of three years, during which time a very accurate wheel record was kept. Owing to the great number of cars and the length of test, the experience of the road just mentioned deserves the utmost consideration. Mr. Turner himself showed me a truck not long ago, which had all four wheels cast in '96, and all of which, with the exception of possibly one, were in first-class condition. The truck was in constant service for 13 years and made 97,651 miles.

In the year 1902 Mr. H. S. Bryan, another pioneer in this field, Superintendent of Motive Power, Duluth & Iron Range Railroad Co., published a report showing that the number of worn flanges were reduced from 101 to 16 by using anti-friction side bearings. The test was made with 600 cars, half of which were equipped with plain and the other half with anti-friction side bearings, and the figures above given represent the wheels removed on account of worn flanges at the end of the first year.

Other railroad companies had similar experiences and would not have cars any more without an up-to-date side bearing. In fact, there is now hardly a road in the country which is not trying some form of a device to relieve the friction at that place.

Even a few minutes' observation at a curve, while a train passes, will suffice to show that the continuous grinding of the wheels against the rails must be wasteful and destructive practice, and if we relieve the truck of the friction, which holds it against the rail, we certainly save the wheels.

This is not all. The expense in changing those wheels and the revenue lost while the car is out of commission must also be considered.

The wear on the wheel flanges means a corresponding wear on the rail. The amount, unfortunately, cannot be determined by tests or records, but it is beyond a doubt much larger yet, than that on the wheels, since the rails are made of soft material when compared with chilled cast iron. But the life of the rails also depends on the number of trains passing, their length, and the percentage of cars equipped with improved side bearings, all variable quantities.

To use a wheel to grind the rail while passing a curve takes power, and power means money. It has been found that a locomotive can haul more cars around the curves if the train is equipped with anti-friction side bearings. The P. & L. E. R. R. found a gain of 10% by actual tests, while other writers give figures ranging from 7% all the way up to 15%. Other tests showed that a locomotive on a 6° curve could start 100 tons more. The writer on his tracks, previously mentioned, found again as high as 12%.

Mr. F. J. Cole, Consulting Engineer of the American Locomotive Co., has for the last few months published the most complete and thorough statistics on train resistance ever published, and the following tables dealing with the additional train resistance on curves have been reprinted from his articles.

Curve Resistance.

Authority.		Resistance, 1 deg. Lbs., per ton.	Equivalent grade, per cent.
Penn. R. R.—For low grade freight line		1.00	0.05
" " —From engine entering curve to last car off curve		0.80	0.04
" " —From last car on curve to engine leaving curve		0.83	0.0415
Max Wickhorst 7½ deg. curve		1.72	0.086
Editorial comment: "Resistance generally underestimated."			
Union Pacific		0.80	0.04
Southern Pacific—For each degree below 7 deg		0.80	0.04
Southern Pacific—For each degree above 7 deg		1.00	0.05
Baltimore & Ohio		0.50	0.025
Wellington—1 deg. curve at 12 m. p. h		1.00	0.05
" —1 " " " 22 "		0.50	0.025
" —8 " " " 9 "		1.00	0.05
" —8 " " " 19 "		0.80	0.04
—Possibly in starting		2.00	0.10
—Under best conditions		0.50	0.025
—General		1.00	0.05
—Fast trains alone, from		0.40	0.02
—Fast trains alone, to		0.60	0.03
Boston & Maine		0.50	0.025
Chanute, at 25 m. p. h. — Twist of wheel	0.001	= 0.438	0.0219
Slip	0.1713		
Flange friction	0.245		
Loss at couplings	0.0213		
	0.4387		

Curve Resistance.

Based on an everage of .8 lbs. per ton per degree of curve.

Degree of curve	1.	2.	3.	4.	5.	6.	7.	8.	9.
Radius of curve	5,730	2,865	1,910	1,433	1,146	955	819	717	637
Pounds per ton	0.8	1.60	2.40	3.20	4.00	4.80	5.60	6.40	7.20
Equivalent grade:									
In per cent.	.04	.08	.12	.16	.20	.24	.28	.32	.36
In ft. per mile	2.11	4.2	6.3	8.4	10.6	12.7	14.8	16.9	19.0

Degree of curve	10.	11.	12.	13.	14.	15.	16.	17.	18.
Radius of curve	574	522	478	442	410	383	359	338	320
Pounds, per ton	8.00	8.80	9.60	10.40	11.20	12.00	12.80	13.60	14.40
Equivalent grade:									
In per cent.	.40	.44	.48	.52	.56	.60	.64	.68	.72
In ft. per mile	21.1	23.2	25.3	27.5	29.6	31.7	33.8	35.9	38.0

Degree of curve	19.	20.	21.	22.	23.	24.	25.	26.
Radius of curve	303	288	274	262	251	240	231	222
Pounds per ton	15.20	16.00	16.80	17.60	18.40	19.20	20.00	20.80
Equivalent grade:								
In per cent.	.76	.80	.84	.88	.92	.96	1.00	1.04
In ft. per mile	40.1	42.2	44.3	46.4	48.6	50.7	52.8	54.9

Equivalent grade per degree of curvature—2.11 ft. per mile, or .04 per cent. grade.

In view of the fact that the information on this subject is yet very incomplete and often conflicting, the second table is especially valuable, since it is based on average results, and remembering that the curve resistance is only partly due to friction at the side bearings, the table and the percentages previously given are corroborating nicely. (For an elementary article on train resistance by the author, see the "Railroad Age Gazette," May 7, 1909.)

For a practical demonstration of the problem, the story of one of our pioneer railroad officials of the South and West is recalled. He had to bring the repair cars in on a curve. No electric rope drive was known then. The pinch bar was used for that purpose, and whenever the car was hard to move the side bearings were usually found closed. If so, the cars were first relieved by blocking, after which it took comparatively little power to move them.

Whatever that percentage is, such a reduction in train resistance can only be appreciated if we consider that $170,000,000 are yearly expended in the United States for coal for motive power purposes, and if we further consider that often the governing factor in rating a locomotive is a curve, which means that more cars can be hauled without increasing the locomotive equipment.

Some railroad officials have raised the question whether or not it would be advisable to carry some of the load by the side bearings, thereby relieving the centre plate somewhat.

A three-point support would be well nigh an impossibility, and either the centre plate or the two side bearings would surely have to carry the whole load.

If, of course, the side bearings were so closely adjusted that both sides would accidentally touch under load, no harm could possibly result with a truly anti-friction device.

Construction of Anti-Friction Side Bearings.

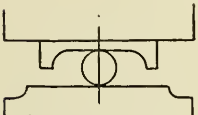
There are possibly 500 different **patents** granted for anti-friction side bearings of various kinds. They are mostly of a recent date, not over ten years old. The majority of them were never built and only a small proportion were actually tried out, and a still smaller number is actually being used.

Whatever the construction of these latter may be, they are all entitled to their share of credit in bringing about better service conditions enumerated above, because their aim is common, viz: the relieving of the friction at the side bearing. It goes without saying that a bearing doing away with all the friction is better than one doing away with only a part of it. A bearing doing away with the friction in any position is better than one which only is an anti-friction side bearing under certain conditions, and a side bearing lasting as long as the car itself is better than one lasting only a few years. It is also clear that a certain degree of reliability must be present, or else the annoyance therefrom might overshadow the advantages otherwise derived.

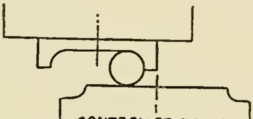
Some side bearings are attached to the **truck** and some to the **body** bolster. There seems to be no advantage in doing it one way or the other, as long as care is taken that no pocket is formed for cinders and ice to get in to clog up the moving parts.

Many side bearings are using **balls** as anti-friction element, while a great many use **rollers** for this purpose, hence the names ball bearings and roller bearings.

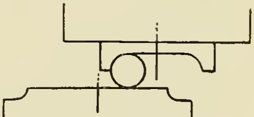
The most primitive arrangement would be formed with two flat bearing surfaces and a roller between them (similar to a rolling pin). Such an arrangement would answer all purposes, provided the roller would always be in the right place, i. e., if the body bolster is central the roller is to be central, as in Fig. 4, if swung to the left, as shown in Fig. 5, if swung to the right, as shown in Fig. 6. One great advantage of such a roller is, that it travels on both bearing surfaces at the same time, therefore, the top and bottom bearing surfaces need only be one-half as long.



CONTROLLED ROLLER
FIG. 4



CONTROLLED ROLLER
FIG. 5

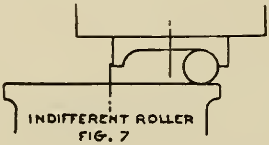


CONTROLLED ROLLER
FIG. 6

Another advantage of such a roller is the absence of any journal friction whatsoever and if the roller is made large enough in diameter, even the so-called rolling friction is so small that the arrangement can justly be called frictionless. This holds good for any roller shown below, except the ones of Figs. 8 and 12. A large diameter has the further advantage of a comparatively wide bearing surface against a mere line, such as would actually be the case with a very small diameter and to still more increase the bearing surface, the roller should be made long. For instance, take a 1″ roller 2″ long and a 4″ roller 4″ long and supposing an equal amount of compression, the bearing surface on the second roller is twice as wide and twice as long, or four times as large, as on the first roller.

It is plain that a cylindrical roller would travel in a straight path, while the other parts of the side bearing travel radially, hence it is necessary to make the roller conical and the two extreme radii can be chosen in such a way that the roller will by itself travel in the proper arc, so that no sliding in axial direction is necessary. Such a sliding would naturally not affect the free swivelling motion, but it would cause the contacting parts to wear rapidly all the same.

It was stated above that such a roller would be ideal, provided it would always be in its proper position. As long as the body bolster is down the roller will always respond to any angular travel the bolster will make, but as the bolster is more up than it is down, conditions will be changed and a good deal of ingenuity and labor has been spent to devise means by which the roller is positively controlled and caused to move properly, whether the body bolster is up or down. Great many patents have been granted on this very principle, showing how important the controlling of the roller is. Unfortunately all these constructions were far too complicated for real service and only one of them survived. About a year or two ago another and much simpler device has been brought out, which up to date has stood up well, and owing to its simplicity, promises a long life.

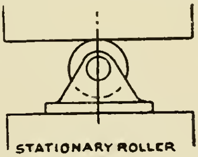


INDIFFERENT ROLLER
FIG. 7

The advantages of a controlled roller is twofold. If made large enough and with the clearance reduced as much as possible, it will last a long time, since the roller at no time can come into a position where it has to slide, and the other advantage, equally important, is that we always have an anti-friction side bearing, i. e., we always protect the car against side bearing friction.

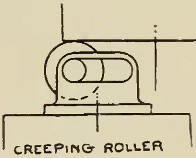
By leaving out such a controlling feature, the roller is **indifferent** to the movements of the body bolster, at least, when it is up, i. e., the roller might be in one extreme position and the body bolster in the other (see Fig. 7), and when the latter comes down and swings around, the roller cannot accommodate such a movement and the principle of the anti-friction bearing is defeated, i. e., the roller has to slide and the friction is the same as with the plain side bearings. Unfortunately such a sliding is now more detrimental, since the contacting surfaces are comparatively small, and flattened rollers can mostly be attributed to this cause.

It may be asked how the roller happened to get into the wrong position. This may have been done by a previous movement of the body bolster, by a sudden stop of the car, or by an incline in the track. It will also be noticed that the truck side bearing has to be long enough to accommodate a roller travel three times as long as that of the controlled roller.



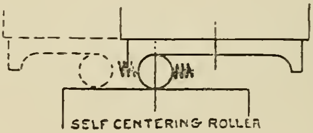
STATIONARY ROLLER
FIG. 8

To prevent such a misplacement of the rollers, some designs show them provided with journals (see Fig. 8), running in stationary bearings, hence the word **stationary** rollers. This works well, provided the mating bearing surface is made long enough to accommodate the total travel of the body bolster. Here it is necessary to make the journals large enough to sustain the load properly, which leads to very large diameters, and consequently the roller will only do away with part of the friction. If the journal happens to be in diameter one-half that of the roller, one-half of the original friction will remain. Mr. F. H. Stark, Superintendent of Rolling Stock of the Pittsburgh Coal Co., showed me quite a number of this class, which had been in service on the Montour R. R. for many years, and the benefit as to flange wear is certainly quite marked. Of course, the larger the journal the less effective the roller.



CREEPING ROLLER
FIG. 9

This again is overcome by letting the journal roll free, giving the roller a **creeping** motion (Fig. 9). However, the bearing surfaces of the journals are now very small, leading to excessive wear. Besides that, we again have an indifferent roller to a certain extent.

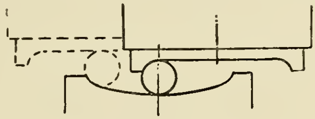


SELF CENTERING ROLLER
FIG. 10

Another way to overcome the indifference of the roller is to make it **self centreing** (see Fig. 10). This can be accomplished by springs, as indicated by the sketch, by gravity, or counter balances. Whatever the means are the principle consists in bringing the roller (or balls) back into central position as soon as the body bolster rises.

Such an arrangement successfully overcomes the journal friction present with the stationary rollers, and, indeed, fine results have been obtained by various devices based on this principle. Unfortunately both the bottom and top bearing surfaces must be twice as long as those with the controlled roller, and if not of sufficient length, sliding would have to take place at the end of an extreme stroke. In case of a series of rollers or balls, such a long travel may be troublesome in other respects.

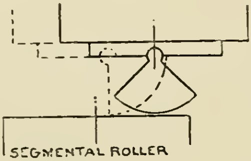
Often when gravity is used as a self-centering means for the rollers, or balls (see Fig. 11), the device has also a tendency to raise the car while entering a curve. Such an arrangement will naturally have a like tendency to centre the truck when leaving the curve, hence the name **truck centering.** Judging from the fact that the outside rail, after leaving a curve, is worn on the inside for several rail lengths, shows that the flange of the outer wheel, in striking a tangent, hugs the rail for quite a distance. This, of course, is due to the grip between the body and truck side bearings and as soon as an anti-friction side bearing is used, should disappear. Unfortunately we have no data on this specific point at hand. Be it as it may, several devices are truck centering, and as a matter of fact, one railroad previously mentioned uses this feature and has had excellent results.



TRUCK CENTERING ROLLER.
FIG 11

On the other hand, we must admit that with such an arrangement it will take much more power to deflect the truck while entering and while passing a curve, thereby destroying the anti-friction principle to a certain extent, simply to be able to righten the wheels promptly after the curve has been passed.

Of late a steeper cone on the wheel tread, 1 in 20, has been found very beneficial in this respect, and the flange wear was thereby reduced about 10%. It looks that with such a wheel tread the truck will centre itself promptly after passing the curve, if the side bearing friction is relieved. Not only that, but a steeper cone will assist the anti-friction feature in entering, in passing and in leaving a curve, while the truck centering feature, as already mentioned, is detrimental during the first two periods, and beneficial only while leaving a curve.



SEGMENTAL ROLLER
FIG. 12

Another form of roller is shown in Fig. 12. Instead of using the whole periphery only a segment is used. Owing to the large radius of this segment an easy motion is obtained, provided not too much journal friction is set up at the top bearing. In some cases, also, this top bearing has been made free rolling.

The segment is naturally limited to 45 degrees. This in turn limits the travel of this class of side bearing materially and on long cars and sharp curves they will have to slide. The only salvation in getting a larger travel with a segment is to increase its radius. Sometimes this can easily be done, but often there is not sufficient room for same.

Ordinarily the total travel required on a tender is about 4″, on a car 9″ and on a street car about 20″. It is calculated by multiplying the distance from car centre to centre plate in feet with the total spread between side bearings in inches, divided by the radius of the curve in feet.

Bearing in mind that a tender requires hardly half as much side bearing travel as a car does, care should always be taken in testing new devices in a tender, else it may happen that excellent results are obtained in tender service, while on long cars and sharp curves the reverse may be the case. I have seen tests of side bearings which did not show a particle of reduction in flange wear, but later on found out that the balls imbedded themselves sufficiently to let the housing form the bearing surface, consequently it was no anti-friction side bearing any longer and the test was of no value, even greatly misleading. Hence, test and sound reasoning should always go hand in hand.

Balls are often used instead of rollers. They have the advantage of not being liable to catch, which rollers will do if they are not well guided, and the deficiency in bearing surface is generally overcome by using a number of balls. Balls are in the same class as free rollers. The author does not know of any indifferent ones, but he knows several types using self centering balls. Attempts have also been made to positively control the balls, the most practical device in this line possibly being the endless ball race. Such a construction, however, is quite expensive, and so are a good many other designs, especially those requiring a good deal of machining or those of a complicated nature. However, if you take into consideration the reduction in flange wear, rail wear and train resistance, the cost is at its worst a mere trifle.

To overcome the rolling of the balls on each other while rolling, they are sometimes separated by frames or pockets. Such a friction is found to be almost negligible if oil is used, but since a side bearing could not be lubricated conveniently, this item is not to be overlooked.

The results referred to in the beginning of the paper were obtained with cars equipped with anti-friction centre plates as well. Of late a good many roads are trying out similar devices. Some use balls, some conical rollers. Some centre plates are made to raise the car during angular motion, others don't.

It will be remembered that for about 90 per cent of the time during transit the whole load rests on the centre plate. During this time no swivelling motion is required, but a maximum bearing surface is very essential. During the other 10 per cent of the time the load rests on the centre plate and one side bearing, and considering equal loads on each, the frictional resistance on the side bearing against swivelling is at least eight times that of the centre plate. Therefore, it is certain that the friction at the side bearing should be reduced as much as possible, even to zero, while at the centre plate a large bearing surface should not be sacrificed under no consideration.

Besides that, on a downward tangent both rails wear on the inside, which indicates that the truck noses more or less in a snake-like fashion from one side to the other. This is on a straight track where the side bearings do not come into play, and it certainly looks that some friction at the centre plate is wanted to avoid this nosing of the truck.

Always use the right kind of material so as to get a hard wearing surface without taking any risk of breakage. For this reason malleable iron is often used for the housings, while the bearing surfaces are formed of harder material, such as unannealed malleable iron, chilled iron, hardened steel and steel castings. The latter is an especially valuable material since its hardness can be greatly increased by a slight addition of carbon without materially decreasing its toughness. If desired, a still more suitable material could be obtained by subjecting the steel casting to a special heat treatment. In fact, there is no limit in this respect, especially if case hardening is resorted to, which would give us a surface as hard as glass with a strong and tough backing. However, it is not well to use too hard material, else the contacting surface will remain merely lines and disintegration is more liable to take place under heavy loads.

Simplicity in any construction and especially in any freight car construction is one of the most important considerations, and a side bearing is by no means exempt from this rule.

Having once a simple device and that simple device made of the proper material, there is no doubt that we can look for a long life, a life as long as that of any other detail on the car, making an anti-friction side bearing the best investment on the car.

Briefly summarizing:

It reduces flange wear.
It reduces rail wear.
It reduces train resistance.
It makes a better riding car.

PRESIDENT: This is a subject in which a great many people are interested and should bring out an extended discussion. I will ask Mr. Edwin S. Woods, of Chicago (who, I believe, manufactures side bearings), to open the discussion.

MR. E. S. WOODS: Members of the Railway Club of Pittsburgh and Gentlemen—I am very glad to have been here and listened to Mr. Stucki's most excellent paper. I have given a good deal of consideration to the center and side bearing question during the past eleven years; this matter has been particularly alive during that period on account of the advent of the large capacity car.

In regard to Mr. Stucki's paper, there seems to be small field for controversy anywhere, but there are one or two points on which possibly some question might be raised. In regard to the 12″ center plate (under a 50 ton car) with its 100 square inch area and load of 650 lbs. per square inch; it must be remembered that when we enlarge the diameter of the center plate we also increase the tendency of the truck to turn hard. The further out we get with the center plate radius, the longer lever arm we have to contend with. In regard to the swinging of the car laterally, this is a particularly bad situation for the body bolster. It induces serious strains not encountered at any other time. It is a bad condition for wear on the center plate and a bad condition for the swiveling of the truck. It is a particularly bad condition for any anti-friction type of center bearing, for the reason that it concentrates the load on two or three of the anti-friction elements.

Heretofore I think there has been some tendency to avoid the solution of the anti-friction center plate question, perhaps due to the more numerous difficulties surrounding that problem than surrounds the anti-friction side bearing proposition. I believe, however, that the problem is capable of solution upon a basis which contemplates the compressive stresses being always kept within the elastic limit of the materials used. I believe an anti-friction center bearing can be devised that will have its stresses so arranged that malleable iron might be used for the plates and rollers in certain cases.

In regard to anti-friction side bearing clearance: As far as the bearings themselves go, I believe there is no question that the clearance ought to be minimized as far as reasonably possible. We must not lose sight of the fact that the greater the clearance the greater the tendency of the car to list and stop the free turning of the truck. There also results increased load on the side bearings when the clearance is taken up, as in going around a curve.

Referring to the advantages of anti-friction side bearings: It may be of interest to quote from the proceedings of the Western Railway Club: "The sense of this quotation is that Mr. M. K. Barnum investigated the percentage of wheels condemned for worn flanges for a period of one year on a total of five roads under various classes of equipment. Passenger removals were from 12 to 31%, locomotive and tender removals from 29 to 41%, freight removals from 48 to 62%. These figures are given to prevent the possibility of error."

On the matter of flange wear the tests made by the D. & I. R. R. R. on anti-friction versus friction side bearings, showing 85% reduction, seem to me large, to say the least. I am familiar with some other tests along this line, very carefully made, on passenger equipment running between Chicago and the Pacific coast, where the flange wear reduction averaged 37%. Of course, this will depend very largely upon how the load is carried; that is, how it is distributed between the center and side bearings.

In regard to reduction of draw-bar pull due to anti-friction media for car supporting, I certainly do not want to appear pessimistic, but I think some of the tests we see show a little high rather than a little low. The side bearing does not need a 10 or 15% draw-bar pull reduction to commend itself—a 4 or 5% reduction would be sufficient. I am familiar with a test made about seven years ago on roller versus flat side bearings and all flat center plates which showed a reduction in draw-bar resistance of something like 9%. Of course, you are all familiar with the tests made by the M. C. B. Association in 1900 letting a car drift down an incline on to a curve, fitting the car with various side bearing equipment. The distance which the car drifted under the several conditions was 176 feet as a minimum and 346 feet as a maximum.

Having reference to the general subject of tests and the interpretation of test results: Test quotations are often misleading and conclusions should be drawn only after intelligent consideration of all the facts. Even then it may be difficult or almost impossible to draw safe conclusions.

In regard to the construction of anti-friction side bearings: I do not want to do more than touch upon it in one or two places. Let us assume that anti-friction center or side bearings ought to reduce friction—the ordinary commercial device—from 85% to 95% as compared with flat rubbing surfaces. They can be made to reduce friction somewhat beyond that, but it is a question of the expense incident to this further reduction, whether it is worth while.

In regard to the coning of the side bearing roller: Personally I do not think it is necessary under ordinary conditions. Let us consider a 36′ freight car on a 35 degree curve and free side bearing rollers. The movement of side bearings each side of the center of the truck on a 30″ radius is about 2½″ and the roller has to travel only 1¼″. The difference between the curve and the straight line, in other words the ordinate, is so small that it is hardly noticeable or measurable. Of course, it is larger on passenger cars. A 70′ passenger car on a 20 degree curve has a movement of 4″ on each side of the center at a distance of 44″ out, but there is not much necessity for coning there, the ordinate being less than 1-16″. I believe there is necessity for coning rollers in street car service. As far as sliding goes, due to the roller not being coned, I would suggest that if rollers show flattening from this cause, the case is proven; otherwise not.

On the question of controlled or non-controlled rollers, each has its advantages and disadvantages. The former is at a disadvantage because from its definition it always presents the same contact surfaces to each other; the latter because it may get into the position shown in Figure 7. To what extent the uncontrolled roller occupies such position will be generally determined by the amount of adverse wear which is developed; if we do not find adverse wear, we may assume that the sliding is negligible. As far as load-carrying capacity of rollers is concerned, I think the uncontrolled roller which is designed to present new contact surfaces all the time will withstand more load without developing adverse wear, than will the controlled roller. I have made some experiments along this line and I think the difference is something like four to one in favor of the uncontrolled roller as to carrying capacity.

In regard to testing side bearings under tenders, Mr. Stucki's point is well taken. However, anti-friction bearings are, I believe, usually put under tenders for test with a view to investigating their wearing qualities rather than determining flange wear conditions. The question is, can you break it up under tenders. If you can not, it will stand up almost anywhere.

In regard to the point of the friction of balls or rollers one on the other: I believe this is a fallacy. The question was brought up by Mr. Henry Hess, of Philadelphia, at the Indianapolis meeting in May, 1907, of the American Society of Mechanical Engineers, and he then pointed out that there was no friction. I believe it is not necessary to go into the mathematics of the question.

In regard to the various relative loads on and movements of the side and center bearings, Mr. Stucki's statement is roughly correct. It might be well, however, to consider how often we have a load equally divided between side bearings and center bearings. I think that is an extreme condition.

The question of the relative advantage of an anti-friction side bearing and an anti-friction center bearing I believe is merely a question of work done at the side bearing and at the center bearing, and this is proportional to the load and the distance out from the center at which it works. I think I covered this subject in a brief and untechnical manner in a letter to the Railroad Age Gazette under date of September 11, 1908, page 921.

In regard to the nosing of the truck, because the resistance to turning of the average type of anti-friction center bearings is by no means nil—for instance considering a 40,000-pound load at 31" lever arm, an ordinary flat cast steel center plate takes about 1800 pounds to turn it. If lubricated it takes about 600. With an ordinary roller center plate it takes about 300 pounds, and some of the higher types of ball bearing devices where almost perfect truth of fitting is obtained between races and balls, we can get the resistance down to about 50 pounds, which is very low indeed.

Regarding the question of material for side bearings and center bearings, I believe a side bearing with a two point or a one point load transmission should be made of hard material. If we get into the question of center bearings, I am not quite so sure about it. It is possible that a softer material which will permit of some small adjustment by allowing seating and do away with the necessity of machine work, which is costly, may be a suggestion along the right lines.

To sum up: I think the anti-friction center and side bearing in order to commend themselves must be so constructed as to be a proper operative for the life of the car. By this I mean that the design must be substantial and simple, and the stresses must be kept within the elastic limit of the material, thus eliminating adverse wear of parts in rolling contact. If these conditions are not met, neither device has any field in railway work.

PRESIDENT: Perhaps we can hear from a railroad man, Mr. R. L. Kleine, of the P. R. R.?

MR. R. L. KLEINE: I am not quite as optimistic as the two gentlemen who have preceded me.

Referring to the kind of material, I might say that drop forged steel center plates are being extensively used in which contact surfaces are smoother than in the cast steel, and less breakage is experienced due to the flanges failing, as a result of shrinkage cracks found in the cast steel center plate.

Referring to the paragraph relative to side bearing clearance:

"On the freight equipment the variations in the height of the bolsters are more pronounced and undoubtedly the best practice is to use flat center plates and adjust the side bearings as close as possible without, however, allowing the ordinary side bearings to become solid on both sides."

In the same connection I would refer to the following:

"For a practical demonstration of the problem, the story of one of our pioneer railroad officials of the South and West is recalled. He had to bring the repair car in on a curve. No electric rope drive was known then. The pinch bar was used for that purpose, and whenever the car was hard to move the side bearings were usually found closed. If so, the cars were first relieved by blocking, after which it took comparatively little power to move them."

In the one case it is apparently satisfactory that little or no side bearing clearance be given, whereas in the latter case, when the side bearings touch it is impossible to move the car. Our standard practice is to give the side bearings from ¼″ to ⅜″ clearance, and we find in some steel cars with rigid bodies that, unless they have clearance, in going over uneven track we get derailments. The same is true of tank cars constructed without steel underframes, in which the tank forms the underframe. One of the Tank Line Companies turned out some cars with little or no side bearing clearance, and derailments were common all over the country until they gave them side bearing clearance.

Another paragraph which reads: "Every time the side bearings close it amounts to a hammer blow." I do not agree with that. A car in running along sways from side to side and when it comes down on a side bearing it does not come down with a hammer blow. While there is a slight blow, I do not believe it is detrimental where the side bearing clearance is within range.

As to the following paragraph:

"With steel bolsters we are very much better off, knowing that they deflect much less, and in accordance with action of the M. C. B. Association, taken some years ago, it is considered safe to have ¼" per side, while on the other hand it was decided not to go above 5-16, so as not to get too much lateral motion."

I do not understand that the Standards or Recommended Practice of the M. C. B. Association specifies the amount of recommended side bearing clearance. But in the last Convention the Committee on Side Bearings made the following recommendations: "Make some tests during the ensuing year comprising the following:

1. The resistance to turning of different type of center plates.
2. The effect of lubricating center plates.
3. The resistance to turning of different types of side bearings.
4. The effect of varying the clearance of side bearings with a view of determining the best clearance.
5. The effect of varying the clearance of side bearings with a view of determining the best spread.

I believe the tests recommended by the Committee on Side Bearings of the M. C. B. Association would produce some very valuable and essential information, and I trust that such tests may be conducted at an early date.

We have tried out in service or are testing at the present time under 7000 gallon tenders the following anti-friction center plates and side bearings:

1. Ball bearing center plate and side bearings consisting of a large number of small specially hardened steel balls in carefully

ground steel raceways embedded in soft metal, so that there would be a good bearing in the plates. The bearing area was fairly well distributed and notwithstanding this the balls embedded into the races in such a large number of cases that it could be considered the rule. Wheel tread and flange contours were taken for the trucks equipped with the trial center plates and side bearings, as well as for those equipped with the standard arrangement, and the average flange wear was practically the same in both cases.

2. The single roller side bearing, as shown in Fig. 4. Two types of this design were tried, the first failed on account of the truck bolster wearing plate not being of sufficient thickness to support weight imparted by roller. This plate was increased in thickness and a new trial started, which is now in progress. The second type of this design is still on trial. The difficulty with a side bearing of this description is to prevent the roller wearing flat and grooving the wearing plates; furthermore, the flat truck side bearing must be well supported to prevent breaking down.

3. The toothed roller side bearing attached to truck proved unsatisfactory, as it filled with dirt, wear was poor and bearing was too short to be supported by truck bolster.

4. The gear principle of single roller side bearing, designed to assist roller in revolving and to prevent roller wearing flat, is still on trial.

5. Side bearing consisting of a number of small rollers in a cage with a spring centering device, attached to truck. This form of roller side bearing in a limited trial on tenders has given satisfactory service and similar results are obtained under wrecking derricks. On general principles this form of roller side bearing should perform better in service than the single large roller in that it has greater bearing area to distribute the weight. Inasmuch as the rollers are encased in a movable cage and have a spring centering arrangement it make the whole device rather complicated. Being located on the truck, it is open to the same objection of accumulating cinders and dirt to interfere with its operation. A further trial is being made to determine tire efficiency.

6. Lubricated side bearings. Our experience with the old

diamond wooden bolster truck, in which the truck bolster side bearing is equipped with sponging for lubrication, demonstrated the difficulty of keeping the sponging in condition so that it would lubricate the side bearing.

To sum up: From our experience I believe it is only fair to state:

That the question of anti-friction center plates and side bearings for the 100,000 pounds capacity equipment is still largely in an experimental stage, since the manufacturers and designers are constantly making changes to enable their devices to meet service conditions under heavy equipment.

That it must not be overlooked that the ordinary freight car having a non-oiled center plate and side bearing, but with side clearance, will in tracking rock from side to side and during the oscillations the top and bottom bolsters are free to rotate on the center plate, and that this oscillation is a very potent feature in reducing what might otherwise be an intolerable amount of friction.

That further experiments should be made with the different forms of center plates and side bearings, which seem the most promising, the data to include economies in tire wear.

PRESIDENT: Mr. George G. Floyd, Chief Mechanical Engineer of the American Steel Foundries, is here and ready to tell us something about this subject.

MR. GEORGE G. FLOYD: It was not my purpose in coming here to make a speech. I came especially to hear the paper, the discussion and to get ideas.

Mr. Stucki's paper has greatly interested me, as it has no doubt all here, and he is to be congratulated for having presented it, and the club is certainly to be congratulated on being able to listen to a paper by one who so thoroughly understands the subject.

The particular branch of industry with which I am connected is the manufacture of cast steel bolsters. Our bolsters have been sold for a great many years, and are now for that matter, under a guarantee to perform a certain service for an agreed number of years. We have sold bolsters to practically every road in the United States. Each customer has a different idea as to the bolster he wants, the type, particulars of design, style of center plate, spacing of the side bearings and the side bearing clearance.

At first the railroads wanted the same side bearing clearance on cast steel bolsters that they were used to with the wooden bolsters. We have been asked to make this clearance as much as 1" on each side. After it was demonstrated that large side bearing clearance was not needed on metal bolsters, for the same reason that it was needed on wooden bolsters, the matter has gotten down to one of difference of opinion as to what is the best clearance. The general tendency is towards a smaller clearance. The general railroad specification today is for not less than ¼", and not more than ⅜"; still many ask for more than this.

We keep a record of all bolsters that do not meet the guarantee, and while replacements are no great burden to us, still they amount to something in the course of a year. As our railroad friends do not seem to agree in the matter; in fact, they sometimes radically disagree, we are going to the expense of building practically one-half a mile of track in our back yard with an incline of sufficient length to give cars going down a speed of 30 to 35 miles per hour. We expect to begin operations next week, and, incidentally, we will probably experiment with center plates and side bearings. One of the principal reasons for building this experimental track is to test what effect side bearing clearance has on producing a blow on the bolsters at the side bearings. A great many of the bolsters returned to us are broken right at the side bearings. We expect to find out what this blow amounts to. We also expect to run out a series of experiments on the results of trucks getting out of square, and how much they get out of square.

I am not well versed in anti-friction center plates and side bearings, but I believe that by their use, especially anti-friction side bearing, clearances could be made smaller, than without them, and the effect of the so-called side bearing hammer blows could thereby be greatly reduced. This may be the means of lengthening the life of bolsters, and possibly reducing the number of broken flanges.

We will be under many obligations to any of you gentlemen here for ideas on subjects in reference to the experiments we are about to make. If you have any special ideas or notions on the subject, our experimental plant is at your service.

PRESIDENT: We have a member here who is always willing to say something, Mr. F. H. Stark.

MR. F. H. STARK: Mr. President and Members of the Railway Club of Pittsburgh—I am disappointed in not having been called upon earlier. Our worthy President usually takes advantage of my size and proceeds to break the ice, or in other words, makes a monkey out of me to pull the chestnuts out of the fire, in order to get the discussion started. Anticipating this, I usually come prepared to do some talking, even though I may not say anything.

The subject matter under discussion this evening is second only in importance, from a railroad mechanical standpoint, to that of draft gear and car wheel material. The first, in so far as cost for maintenance, and the latter as a matter of safety to property and lives, as well as expense. The subject of center plates and side bearings is very closely related to that of car wheels, and thus we might group the three subjects and combine them in two propositions, viz: draft gear and truck gear.

The author favored this Club with a paper on the subject of friction draft gear, which, without question, was the most clear, concise and the most comprehensive treatment of the subject yet recorded, and this Club should congratulate itself for having a member who is recognized authority on subjects pertaining to the design of railroad cars.

Referring to the character of material: It is found from experience that malleable iron of average quality will not stand up in service under cars of 80,000 capacity or over, and it has been found necessary to substitute steel or drop forge castings.

Mr. Stucki refers to spherical bearing center plates. I recall years ago, when this type of design was quite prevalent, that serious trouble was experienced, due probably to bad shop practice. If a moulder was careless and rapped the pattern more in one direction than in the other, it is liable to cause the bearing area to be oblong rather than a true circle. In any event, while the center plates appeared to mate properly when two center plates would move in an opposite direction, the top plate was forced to raise vertically in order to rotate. This condition under a loaded car would lock the center plates. I remember a series of cars that it was almost impossible to move them over a division without derailment, and the center plates had to be changed. I recall a case where a heavy wrecking car was continually derailed and the center plates had to be machined to overcome the trouble. Therefore, I believe the author is correct in stating that a plain flat surface bearing of adequate area is the most practical. In this connection I would ask the author to consider reversing the position of our standard center plates. In the early design of composite cars the bowl of the male center plate, together with brackets supporting the bed or flanges, made it possible to transmit the load to a point more directly under the center sills. If a female center plate had been attached to the car body, the bearing area being less in diameter than the distance between the draft timbers, the ordinary two plate bolsters would buckle up in the center and allow the load to rest largely on the side bearings. With steel car construction this difficulty is not encountered, and even composite cars with substantial metal body bolsters, it is practical to attach the male center plate to the car body. Some years ago, when I was on the C., L. & W. Ry., we built a lot of cars with the center plates reversed, with very good results. The advantages in so doing is to provide a self-clearing center plate and not a pocket which would hold the iron ore dust, grit, etc., which has a tendency to retard the free rotation, as well as prematurely cutting away the bearing surface. The distance between the rail and the desired floor line of a car is so limited that it is difficult to design a low truck with minimum dead weight, and in order to provide a substantial body bolster the space allowable for center plates is so contracted that I doubt whether a roller bearing center plate can be designed in the limited space that would prove satisfactory, and believe that a flat bearing area using steel castings, with a larger portion of the load carried on substantial roller side bearings, will permit the continued use of plain flat bearing center plates.

Mr. Stucki refers to the deflection of bolsters and as a practical illustration of the effect in the way of resistance or draw-bar pull necessary to move cars with load bearing hard on plain side bearings, I will cite a case which is common experience everywhere. At one of the lake ports a car dump machine is located where the loaded cars are placed on a decline with a moderate curve. I had occasion to visit this port not long ago and found that the wooden cars with flexible body and truck bolsters would not move by gravity and pass around curves without being followed up with a pinch bar. In order to relieve the situation the inside face of the rail head was lubricated, and in doing so, more or less of the grease would get on the top surface of the rail, and in turn would adhere to the wheel treads very materially effecting the brake efficiency, and on this account the cars had to be moved down an incline at a slower rate in order to maintain control and stop the car on the machine. Failing to do this, the loaded car would pass over the car dump machine and come in contact with the empty car that had just previously passed over the machine, and on its return over the switch back, and frequently cause serious damage to the two cars. The superintendent of the dock estimated that they could unload a much larger percentage of cars if the old wooden cars would gravitate down the decline without lubricating the rails and without the delay of following such cars up with a pinch bar, and in the absence of oil on the rails the cars could be moved at a faster rate with safety, and thus very materially increase the tonnage handled over the car dump machine. The point I wish to emphasize is that if modern cars with rigid bolsters will move by gravity with less resistance than cars bearing hard on the side bearing, it is obvious that cars equipped with practical roller side bearings would still more reduce the resistance.

The author calls attention to the various means of adjusting the relation of side bearings and refers to the bottom member forming a pocket with a metal block inside of the frame, supported on a wooden block. For ordinary plain side bearings this is a desirable feature, but the inside member or side bearing should be secured, for frequently when cars are operated over a car dump machine, the car body tilts on the truck and allows the internal parts to fall out and go into the boat with the load. This also applies to some designs of roller side bearings and considerable loss of these parts, as well as brake shoes and keys is involved.

Mr. Stucki refers to the advantage of anti-friction side bearings. He refers to the desirability of standardizing the parts in order to facilitate repairs and reduce the stock of material necessary. In line with this, we might adopt Mr. Wood's side bearing as standard and thus accomplish this end. This might apply to other specialties. Mr. Woods, however. has demonstrated his ability to defend his own case. It has been proven that cars ride better where the side bearings come in contact under load. My friend Mr. Kleine takes the position that the rocking of the car body does not produce a hammer blow. If not, it is the blow that almost kills father, for it is found, on some roads at least, that steel hopper cars or other cars having a high center of gravity, that there are more derailments and flange failures than is the case with other cars having the same amount of side bearing clearance. It is contended that a certain amount of side bearing clearance is essential to compensate for the uneven surface of the track or the elevation on curves. It is also recommended that the clearance of from ⅛" to ⅜" is more desirable than a greater or less clearance. I desire to ask how far ⅛" clearance will go toward compensating for low joints or elevation on a curve, and is it not a fact that composite cars and many of the early designs of steel cars are running with unknown weight on the side bearings and operated in our trains every day?

I can conceive how a short locomotive tender rigidly constructed, or an oil tank car, with a steel body bolster riveted to a tank shell, with a superstructure that might be so rigid as to preclude any considerable tortional yielding, and when such a vehicle is passing over an elevation on a curve, an excess load would be carried on the high side bearing, and even so, this would tend to keep the wheels on the high side of the curve down on the rail, and relieve the load on the wheels on the low side of the curve, and since the wheels on the low side seldom mount the rail, the tendency being to climb the high rail, would not the extra load on the high side carried on roller bearings operate to prevent rather than cause derailment? In the case of cars having too much side clearance and the constant rocking of the car body at a moment when the car lists to the low side, throwing the weight momentarily on the journals on the inside of the curve, relieving the load on the wheels on the high side, allowing same to mount the rail. Assuming that there is more or less flexibility with the average car and that we do safely operate cars with an unknown load on the side bearings, is it not reasonable to assume that a larger proportion of the load might be safely carried on substantial roller side bearings? If so, the weight of the body and truck bolsters might be reduced in so far as the distribution of the metal to carry a vertical load and maintain, of course, a safe margin or factor of safety, so far as the transverse shocks are concerned, caused by coupler impact.

Some twelve or fifteen years ago we designed a side bearing similar to Figure 8, except that the frame was made to take in two rollers. These rollers were about 2½″ face and 4″ in diameter. They were cast in a metal chill with a metal core and carried on case hardened axle pins 1⅝″ diameter, secured in a stationary position so that the rollers rotated on the axle. The opposing side bearing was made of cast iron and the face chilled. We have since equipped some side dump cars with similar side bearings, it being more difficult to maintain a limited load on side bearings under side dump cars, and yet these cars have been in service over five years, and Mr. Stucki had the privilege of examining a number of these cars and found that a large majority of the original wheels are still in service with the flanges in good condition. I am sure that the side bearings are entitled to much of the credit.

There are some side bearings on the market that center themselves by gravity, and yet under load move on a straight plane. In ordinary service the side bearing travel is so limited that I do not anticipate that the rollers would reach the limit in either direction and cause serious sliding, for the rollers will adjust themselves on reverse curves, and at times when the car body lists from one side to the other, but if a side bearing can be designed with a positive automatic centering feature without the use of springs or delicate mechanism, it would be an advantage.

Of one thing I am convinced, and that is in order to utilize commercial material it will be necessary to use rollers or balls of maximum dimensions and in larger numbers. We cannot expect a reasonable period of service where the load is carried on so small a bearing area without producing recesses in the bearing surfaces and thus defeat the desired object of unretarded movement. The bearing surfaces should be of a material somewhat like spring steel. This to be backed up substantially by some commercial material, and instead of one roller there must be two or three.

I would like to ask Mr. Stucki to enlighten us on the point as to whether it is not feasible to carry more of the load on the side bearings and thus reduce the first cost of body and truck bolsters and reduce the dead weight, which is equivalent to increase of weight of freight carried. To inform us as to whether there is any objection to our reversing the position of the center plates and the continued use of plain flat center plates made of cast or drop forge steel.

PRESIDENT: Mr. Turner has been brought into this discussion.

MR. L. H. TURNER: I fully realize the importance of the subject under discussion this evening and have given much attention to it, and must confess that I cannot understand the apparent apathy on the part of the mechanical men and railroad managers of this country on a subject, which, if followed up, is pregnant with so many good results. When the first freight car was built in this country, the journal was lubricated to keep it from heating and to assist in making the car haul easily. They are today still lubricating the journal, and while other parts of the car have been re-designed time without number, not one thing has been done toward making the car haul easier.

While Mr. Stucki was reading his paper, I put down a few figures which will serve to illustrate the possible economies of using some device which will make the car haul easier. You may take a train of 50 cars carrying a load of 55 tons each, and haul it 100 miles, and you have 275,000 ton miles. At 6 mills per ton, which is the prevailing rate today, the train would earn $1,650.00 on the 100-mile haul. To equip these cars with a good frictionless center plate and side bearing would cost $1,500.00. It is not an exaggeration to say that 10% might be added to this train and could be hauled, making equally as good time, with little or no more expenditure of locomotive energy. Six mills per ton mile on the additional 10% of load would amount to $165.00. This amount of money would pay the interest on the cost of the frictionless center plates and side bearings for nearly two years, or if you desire to apply this in paying for the equipment, each 100-mile haul would pay for five cars, and in making ten 100-mile trips, the entire equipment would be paid for, with the prospect before you of quite a number of years of good service in which the additional earnings would be clear profit.

A truck that does not adjust itself readily to the varying conditions of the average track, not only impedes the progress of the train, but wears out the rails and wheels. I predict that the time is near when railroad officers will see not only the advantage, but the necessity, of giving this subject more intelligent attention than it has received in the past. I have spent weeks in dynamometer cars making tests with trains with the ordinary center plates and side bearings, as well as those equipped with frictionless center plates and side bearings, and I feel justified in saying to Messrs. Stucki and Woods that they will not gain all the results that can be obtained by the use of the frictionless side bearing alone. They must also have a frictionless center plate and insist on the load being carried largely upon the center plate in order to reduce the rolling friction to the minimum.

There has been some discussion about the deflection of bolsters. A bolster should not deflect, it should be made strong enough to retain its original position during the life of the car under all conditions. We place springs under the bolsters to receive shocks, and I am not in favor of making the bolster perform this service. Some criticism has been offered concerning the failure of some of these devices placed upon the market. Nothing else could be expected, every new device has to pass through an experimental stage.

While I am not here for the purpose of defending any particular device, I feel that I am justified in saying that while mistakes have been made, that every advantage was taken of all knowledge existent at the time on the subject of metals. We must remember that it is but a comparatively few years since steel castings were introduced, and there is still much improvement to be made in their manufacture. It must also be remembered that our chemists during the past few years, through laboratory and physical tests, have accomplished wonders in improving the manufacture of metals, and there is no reason today why all cars cannot be equipped with frictionless center plates and side bearings, and the cost of maintenance will be no greater for the amount of money invested than for any other parts of the car.

MR. WOODS: As to Mr. Stark's suggestion of the reversal of the ordinary flat center plates, it has occurred to a good many people that this is the proper way, viz: have the male center plate on the truck bolster, and at least one transcontinental system in Canada has begun to realize this and are so designing their equipment.

MR. STARK: I would like to ask Mr. Turner what is the objection to distributing the load on three points? You are limited in space between your bolsters for the center plate and you have greater space for side bearings. If you are going to have anti-friction bearings at all these points why not carry the load at all three points and in that way reduce the stresses on bolsters and at the same time increase the roller bearing area.

MR. TURNER: In reply to Mr. Stark's question as to why I recommend that the load be carried on the center plate, will say that it can be illustrated in a very homely way by stating that anything in the way of a heavy beam balanced upon the center can be swung with much more ease than though it rested on three bearing points, the same weight upon each.

MR. JULIUS KRAUSE: The subject which we have listened to this evening is an important one—and as our friend Mr. Stucki states, that many patents have been granted and quite a number have been tried out with more or less success. While every inventor claims his device is the best and is hopeful that it will be adopted by the railroads, and quite a number, after being applied, prove a failure. This may be caused by the rapid increase in weight of the equipment, and the most serious defect is the breaking of rollers and balls and raceways, and balls imbedding themselves in center plates. Also such defects as severe train service, caused by increased tonnage being hauled in one train, and car dumping machines, when not properly operated, cause balls to become lost from center plates and side bearings.

I find that the M. C. B. standard center plates with 100 square inches of bearing surface when applied on 100,000 capacity cars, placing 700 pounds on every square inch, my experience has shown that lubrication will not remain between truck and body center plates, but the grease will be found squeezed out over flange of truck center plate after one day's service, while on 60,000 capacity cars, with center plates carrying 430 pounds per square inch, lubrication can be retained.

It is my opinion if center plates on 100,000 pound capacity cars were increased to 15 inches, lubrication could be retained. Mr. Stucki claims that quite a number of cars are derailed on account of flat side bearings, and that this also causes flange and rail wear, and if anti-friction side bearings were applied that this would be obviated. I believe Mr. Stucki will agree that the curve will remain and also elevation on outside of curve, and flanges of wheels will be forced against outside rail while passing over curve, which will cause wear even if equipped with anti-friction side bearings. He also refers to cars being derailed by flat side bearings not allowing truck to curve freely. There are different opinions on this subejct.

My opinion is that not enough attention is given to the height of center of gravity of load, derailments of this kind generally taking place when car passes over curve at a slow speed, and car leaning to low side of curve and center of gravity over eight feet high.

Mr. Stucki refers to Mr. Turner as being the pioneer of anti-friction center plates and side bearings. I admit that he has labored earnestly to bring it to perfection. About four years ago I visited Mr. Turner's car shop and his general foreman, Mr. G. E. Carson, called my attention to the Hartman Anti-Friction Center Plates and Side Bearings, which were of cast iron, with six balls in center plate and one in side bearing, and some were found broken, and center plates showed dents where balls rested; but a change has been made since, increasing the number of balls from six to eight in center plate, and from one to two balls in side bearing, and the metal from cast iron to drop forged steel, and I am informed that this has increased their life and giving better service.

MR. WOODS: I merely mentioned the matter of lubrication for purposes of comparison, not to advocate lubrication or non-lubrication of the ordinary friction center plate, though I do know at the present time of 40 and 50 ton cars lubricated with reasonable success by the use of graphite. I believe it is not as successful as it might be.

About the sustaining power of balls and rollers, a device that is put under a car to act as an anti-friction medium must be designed on lines which will keep the stresses under the elastic limit of the material and well under it. I could cite figures, but I do not believe that would be interesting. But unless that condition is maintained we might just as well give up the idea of anti-friction car supporting media.

R. H. BLACKALL: The discussion has been intensely interesting.

There is one thing in particular that I have noticed and I think that everyone has, that all have been frank in saying things favorable to anti-friction center and side bearings, and equally frank in bringing up objectionable points. One thing everybody seems to agree upon and that is that theoretically anti-friction center and side bearings are all right. This being true, it is simply a question of which of the devices contains the greatest number of good features and will stand up the best in service.

Personally the first information I had on this question was about four years ago when with the Westinghouse Air Brake. While we were helping to make some tests in the West we found that with four different 50-car trains, absolutely the same as far as we knew outside of the draft gear in them, we had one train with which we did not have to go back within three-fourths of the distance to get up speed that we did with the others, and, if we desired, we could get up a speed from four to six miles more than we could with the other trains. We began to look around to find the reason for this, and discovered that 25 of the 50 cars with which we could get up this greater speed were equipped with frictionless side and center bearings. When this condition was brought to the attention of the railroad officials they said, "Let us find out what there is in it." So they took the trains down to a hill where the grade was about six miles in length. They made up 25-car trains and loaded the cars with gravel and had almost exactly the same tonnage on the different trains. The same engineer, crew and engine were used on the different tests, and we found that on that six miles of grade the train with frictionless side and center bearings could be pulled up the grade in 12 minutes less time that could be done with the train having plain side and center bearings.

From this it will be seen that there is absolutely no question but that more tonnage can be handled when cars are equipped with frictionless bearings. This means also less flange wear on the wheel and correspondingly less wear on the track.

There is absolutely no question as to frictionless bearings being a good thing, but, as already stated, it is a question as to which of the different types of bearings contain the greatest number of good features and whether these will stand up under service conditions.

MR. KLEINE: The last remark should, I think, be elaborated upon, and we should get out a little more data at this meeting on the actual service trials of the anti-friction side bearings and center bearings that are now on the cars. I do not suppose there is a railroad man in the room who would not instantly install these bearings if he were assured that they would stand up in service. If they should not stand up in service we are going to run into trouble with derailments, especially with some forms on the market, and no one is going to go to anti-friction side bearings and center plates if there is no assurance of getting at least ten years' service out of such bearings.

(The Secretary here read two communicated discussions as follows:)

Baltimore, Md., November 22, 1909.

Mr. C. W. Alleman, Secretary Railway Club of Pittsburgh, Pittsburgh, Pa.:

Dear Sir—In behalf of the T. H. Symington Co. I desire to express our appreciation of your invitation extended to one or more of our representatives to attend the meeting of the Railway Club of Pittsburgh on November 26th, when Mr. Stucki will read a paper on the subect of "The Side and Center Bearings of a Car." The writer is extremely regretful that business engagements in the East just at this time make it impossible for him or any of our representatives being on hand. However, Mr. Stucki has presented the subject in so able and thorough a manner that we find but little to say except to endorse, with some few exceptions, what Mr. Stucki has said.

One of Mr. Stucki's statements which is not entirely clear to the writer is the paragraph referring to a comparison between the action of the self-centering roller and what he terms the "controlled roller." I quote the paragraph referred to:

"Such an arrangement successfully overcomes the journal friction present with the stationary rollers, and, indeed, fine results have been obtained by various devices based on this principle. Unfortunately both the bottom and top bearing surfaces must be twice as long as those with the controlled roller, and if not of sufficient length, sliding would have to take place at the end of an extreme stroke. In case of a series of rollers or balls such a long travel may be troublesome in other respects."

For a given travel of the side bearing I do not understand why the bottom and top bearing surfaces must be twice as long for the "self-centering roller" as for the "controlled roller." The extreme available travel of the controlled roller is limited by the length of its retaining casting, and the same is true of the self-centering roller, the action of each type of roller being the same when the top and bottom members of the side bearing are in contact.

Another paragraph in Mr. Stucki's paper which we think is deserving of further explanation is the one referring to nosing of the truck. Interpreting this paragraph strictly according to its reading would indicate that Mr. Stucki does not believe in frictionless center bearings. It would be, no doubt, of interest to the Club members to have Mr. Stucki state just how much friction at the center plate "is wanted to avoid this nosing of the truck" on a downward tangent. Recently the writer had occasion to make a comparative test of the nosing of the trucks on straight track under a car equipped with ball bearing center plates and the same car equipped with center plates of the usual type. In this instance the data obtained convinced the management of the railway that the nosing of the trucks when equipped with ball bearing center plates was no greater than when equipped with ordinary center plates. A ball bearing center bearing of proper design requires relatively so small a pressure at the wheel flange to produce a turning movement between its two members, even under very heavy loads, that it is reasonable to conclude (even on the assumption that a truck so equipped would nose more than when equipped with ordinary center plates) that this small pressure would not result in any sensible wear on the rails on a tangent. On the contrary, a truck equipped with center plates of the usual design requires so much pressure at the wheel flange to produce a turning movement between the upper and lower members under heavy load that it is reasonable to conclude that any nosing of the truck which takes place on a tangent (even though this nosing be less frequent than with frictionless center plates) will result in very appreciable wear on the rails. An amount of friction at the center plates sufficient to prevent nosing altogether would doubtless at times result in the trucks entering a tangent somewhat askew and remaining in this position for the entire length of the tangent.

So far as steam roads are concerned, the chief obstacle to date in the way of a general adoption of what are termed "frictionless" center and side bearings has been the difficulty of obtaining devices in this line having sufficient strength of the wearing parts to withstand the loads and shocks occurring under modern heavy passenger and freight equipment. We believe it is generally admitted by the mechanical officers of steam roads that a satisfactory ball or roller center and side bearing (that is, durable devices of this character) are very desirable, and would result in a very sensible increase in the life of wheels, so that it would seem to be "up to" the manufacturers of specialties in this line to prove durability to meet all modern service conditions as well as the positive action at all times of the balls or rollers. The first essential feature to accomplish this is simplicity of design, as it is a matter of experience that anything in the nature of complicated mechanism will not remain in working order under freight cars. The second essential feature which I think most of those who have had any experience in the test of frictionless center or side bearings will agree is essential, is that the balls or rollers should be retained in the car body member of the bearing to insure against clogging of parts by dirt or exposure to the weather. The third essential feature, which applies, however, only to a ball or roller side bearing, is that there should be some means of positively centering the balls or rollers after travel.

One of the complaints of the single-roller side bearings which have been put in service up to this time has been the rattle of the roller in its retaining casting, which is due to the play between the top of the roller and the top bearing surface with the body bolster level and the roller supported on its trunions. A single-roller side bearing has been recently placed on the market in which the roller is positively centered by a helical spring at each end of the retaining casting, which springs at the same time exert sufficient downward pressure to hold the roller down tight on its trunions when it is not in contact with the truck member.

Yours very truly,

A. H. Weston,
Mechanical Engineer.

Chicago, November 24, 1909.

Mr. C. W. Alleman, M. P. Dept., P. & L. E. Railroad, Pittsburgh, Pa.:

Dear Sir—I am in receipt of your esteemed favor of the 17th inst. enclosing a copy of Mr. Stucki's paper, entitled "The Side and Center Bearings of a Car," and thank you very much for your invitation to me to be present at this meeting. I regret very much my inability to be with you, but have read Mr. Stucki's paper very carefully, and consider that it portrays very valuable information to any one interested in side bearings.

I have looked into this matter very extensively, and am confident that it is one part of a railroad car which has received the greatest neglect. I never have known of a side bearing test which did not prove that an anti-friction side bearing was a very valuable adjunct to a railroad car. The leverage between side bearing centers is so great that friction between them necessarily places a great strain on wheel flanges. And whenever you are wearing the flange of a wheel your engine is burning more coal than is necessary to carry its load.

It has been claimed by a number of persons that where clearance can be maintained between side bearings, anti-friction bearings are unnecessary. This is true, but in order to maintain side bearing clearance on both bearings of a truck bolster, it is first necessary that the load in the car be properly centered. It is then necessary that the rate at which that car must pass all curves must be such that the center of gravity will not be affected by centrifugal force sufficiently to place the weight upon either side bearing. When we know that these things are absolutely impossible, therefore, we know that it is impossible to affect side bearing clearances at all times, and if we cannot, then an anti-friction side bearing is the only remedy, and by actual experience we know that anti-friction side bearings permit more cars to be hauled with one engine using the same amount of coal, and prevent in a very great degree the wear on wheel flanges.

Yours very truly.

J. R. Cardwell.

PRESIDENT: If there are no others here who would care to discuss the subject further I will ask Mr. Stucki to close the discussion.

MR. A. STUCKI: I certainly feel fully repaid for my work in preparing this paper by the discussion it brought about. I think there remains very little for me to add.

Mr. Woods has mentioned that it takes a good deal of power to turn an ordinary flat center plate. This is true, if the two center plates lay flat on each other, as was the case in the different tests. This is also the prevailing condition on a straight track and the resistance towards swivelling must help to prevent the truck from nosing. Mr. Weston asks, how much friction there would be necessary to prevent such a nosing. Undoubtedly this would depend on track conditions, on the cone of the wheel, whether or not the truck is rigid, whether it is driving or driven, and we have no accurate data at hand, at least not to my knowledge.

But as soon as we pass a curve conditions are entirely reversed. Here the body center plate tilts to one side or the other and the swivelling motion takes place on a point near the periphery of the plates, and the resistance towards turning is very much reduced. In other words, on a straight track where we want resistance, we have it, and on a curve, where we want as little as possible, it is greatly reduced.

Mr. Kleine, in referring to one of the pages, read my remarks as though the side bearings on both side of the center plate were closed, while I meant to say that the bearings on the inside, or low side, were usually found closed. In regard to derailments with a stiff car and little or no side bearing clearance, he is undoubtedly right when ordinary side bearings are used, because the entire load may be thrown on one side bearing and the friction will be great enough to lock the side bearing sufficiently and force the wheel to climb the rail. This same condition exists at times even with an anti-friction side bearing, i. e., if the travel of the bearing is not sufficiently large to accommodate the travel of the bolster, but whenever you have a truly frictionless side bearing with sufficient travel, an increased load on the high side bearing will rather help to keep the wheel from climbing the rail, just as Mr. Stark has said a little while ago.

In regard to the now usual side bearing clearance, it being from ¼″ to 5-16″, it is true these dimensions have not been made standard, but have been recommended by the M. C. B. Association some years ago and are now pretty uniformly used.

The rocking of the cars, also referred to by Mr. Kleine, takes place on straight tracks only, where no swivelling motion is needed or wanted, hence the friction during that period is immaterial, except of what has been said regarding nosing. On a curve the cars don't sway; they go down on the side bearings and stay there until the curve is passed.

The question of reversing the center plate, as raised by Mr. Stark, is certainly well taken. Originally it was intended to form an oil receptacle in the lower plate, but since nobody oils the center plates and since the pressure on the high capacity cars is too great per square inch for the oil to perform its function, the arrangement can advantageously be reversed. This will avoid, at least, the accumulation of grit and dirt, and I know of one lot of cars built in this way which gave entire satisfaction.

Whether or not we should carry part of the load by the side bearings, as mentioned by Mr. Stark, depends entirely on the prevailing conditions. All the load has already successfully been carried by the side bearings. All that is necessary is to have an anti-friction member and to have large bearing surfaces. I am very much afraid that in trying to carry the load on three points we would either carry it exclusively on the center plate or exclusively on the side bearings, and to provide for this last mentioned case we would have to have large enough bearing surfaces on our anti-friction side bearings, so as to exclude wear.

In regard to the number and size of the rollers, it is simply a question of contacting area, as dwelled upon in the paper, and it is immaterial whether you have two rollers or one roller twice as long, at least as far as the wearing of the roller is concerned. Otherwise one roller is even better than two, inasmuch as the load is bound to be distributed as intended, while with two rollers one might get more than its share.

Mr. Weston raises the question, why the travel of a self-centering roller is twice that of a controlled one. In the first case, the roller in traveling from its central position to its extreme position has to accommodate bolster travel, covering the distance between the two extreme positions, while the controlled roller in traveling from the center to the end has to accommodate only half the bolster travel, i. e., the distance from its center to its extreme positions. The sketches are drawn to scale.

MR. S. C. MASON: I think this Club is greatly indebted to Mr. Stucki for his most excellent paper. It has developed very valuable discussion of the subject, which ought to bear much fruit. I move, therefore, that a vote of thanks be tendered to Mr. Stucki.

The motion prevailed by unanimous vote.

ON MOTION Adjourned.

In Memory

of

GUY HARVEY DAVIS

General Foreman Car Department
Wabash-Pittsburgh Terminal Railway Company
Who died at
Pittsburgh, Pa.,
Thursday, November twenty-fifth
Nineteen Hundred and Nine

The river of another life has reached the sea, and again we are face to face with the great mystery that shrouds the world.

In the very noon of life another heart has ceased to beat, and night has fallen upon noon. But he lived, he loved, he was loved. Wife and children pressed their kisses on his lips. Friends honored and respected him. This is enough. The longest life contains no more.

Guy Harvey Davis was a kind man, a good man, a generous man, an honest man—and these words build a monument of glory above the lowliest grave. He was our friend. We were his friends. The world is better for his life and braver for his death, and with one accord we pay this last tribute to his honored memory.

H. W. McMASTER,
F. H. STARK,
SAMUEL LYNN,
Committee.

In Memoriam

GEO. T. BARNSLEY

The Railway Club of Pittsburgh, as a Club, and the members as individuals, join the family, the relatives and the friends of the late Geo. T. Barnsley in sympathetic feelings expressive of loss due to the absence of our fellow-member from our midst and from the councils of this association.

"Large was his bounty and his soul sincere"
Surely
"Heaven did a recompense as largely send."

The inherent hope of immortality is strengthened by the desire to again meet a character such as that possessed by Geo. T. Barnsley, who was always a cordial acquaintance, a genial and helpful friend and a sincere and true companion.

We extend to the bereaved family and relatives, and to all who can meet with us in acknowledgement of loss of helpful presence, our sincerest sympathy and fellowship, and recommend that this expression of our regard be spread upon the minutes of this Club.

And a copy be presented to Mrs. Barnsley.

By the Committee:

D. M. HOWE,
J. W. HENDERSON,
F. M. McNULTY.

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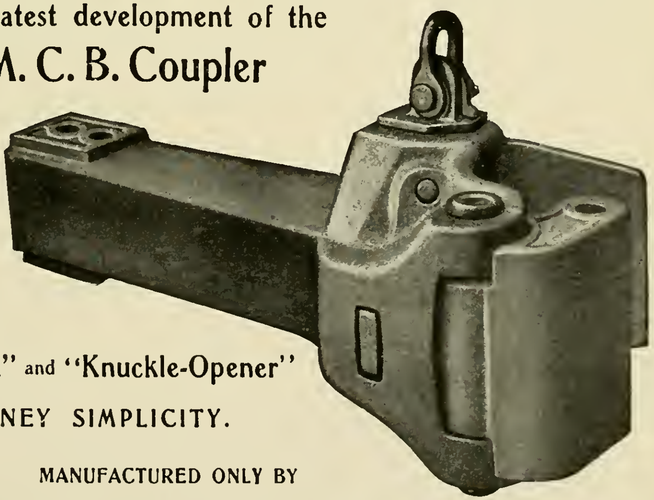

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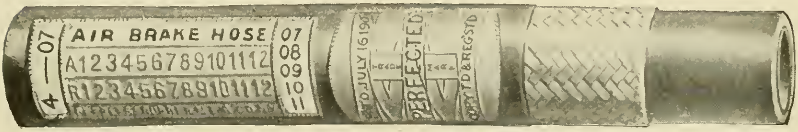

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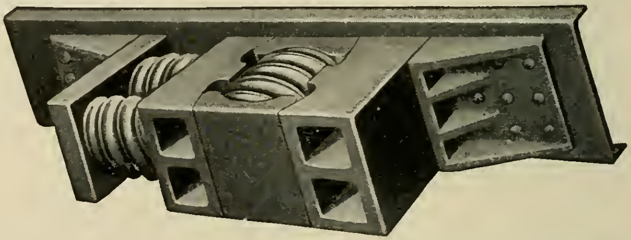

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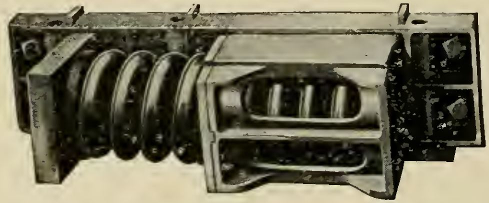

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The Standard Coupler Company
announces the removal of its New York office from 160 Broadway to the sixteenth floor of the United States Express Building, No. 2 Rector Street (rear Trinity Church.)

The Chicago office has been removed from the Monadnock Block to Room 1207 Fisher Building.

The STANDARD STEEL PLATFORM
is now in use by 226 companies.
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Both made by Standard Coupler Company.

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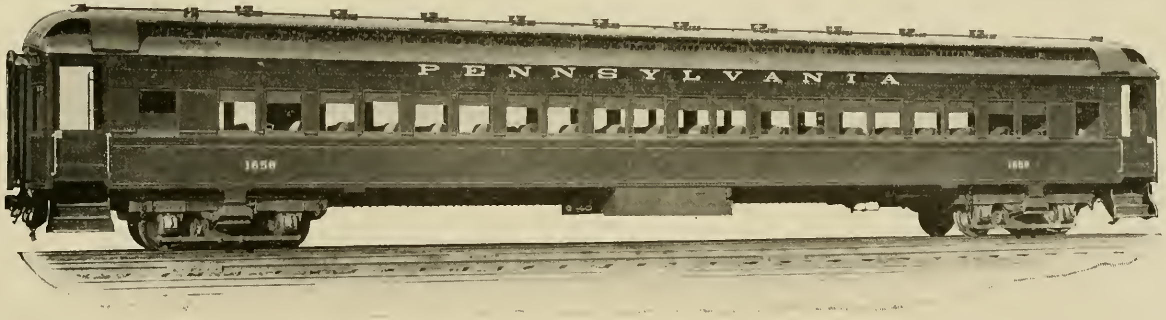

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Testimony From the Actual Users (3*)

ℭ From time to time we have published statements regarding the merits of the "Modern Boiler Tube," i. e., the steel tube.

ℭ In the last analysis, the success of any article must depend upon its own specific merits as evidenced by the experience of actual users.

ℭ At the 1909 Convention of the International Master Boiler Makers' Association held in Louisville, Ky., there was a discussion of the report of the Committee appointed to investigate the respective merits of steel vs. iron Boiler Flues and we quote from the published proceedings the remarks of the foreman Boiler Maker of a large Railroad in the middle west.

> "When I started on this subject of steel flues we were getting 22,000 and 23,000 miles out of a set of flues. We put a test set in and instead of getting 22,000 or 23,000, we got 69,000 miles. I removed the tubes and had them cleaned and examined and found no signs of pitting in them. But in the last two years, I find where the flues have been in service four or five or six years, I find pitting on both the iron and steel, but I do not attribute it to the material, I attribute it to laying the engine up for a month or six weeks at a time. I also attribute it to the flues being taken out of the boiler and put aside and left in the weather, and the rain comes on them and they rust, that starts the pitting. I do not think it is the fault of the steel or iron, but it is the fault of the handling."

ℭ We formerly made both steel and iron boiler tubes.

ℭ Becoming convinced that the steel tube was the more economical we abandoned the manufacture of iron boiler tubes and are now making only Steel Boiler Tubes—THE MODERN BOILER TUBE.

ℭ If you are interested in the boiler tube question, our representative will be glad to go over the subject with you.

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* This is the third in a series of announcements regarding the "Testimony From the Actual Users." Others have appeared in previous issues and will appear in later issues of this magazine.

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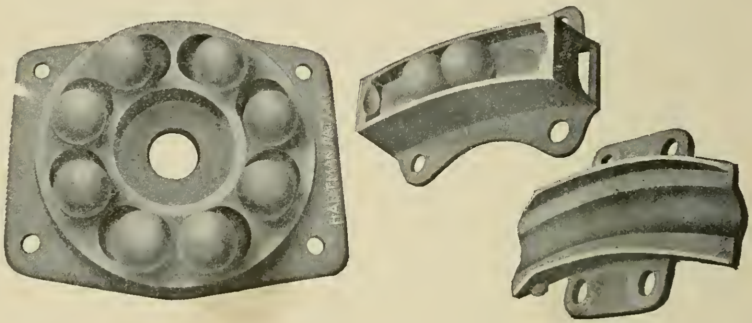

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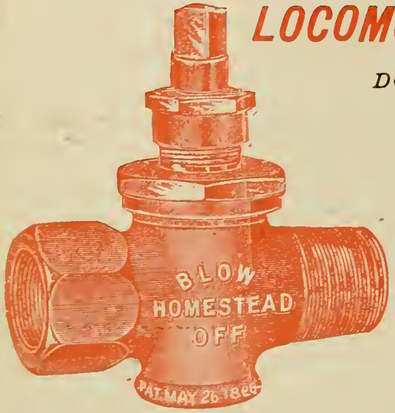

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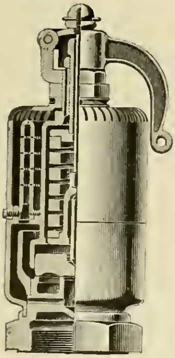

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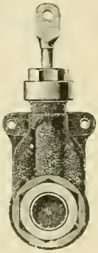

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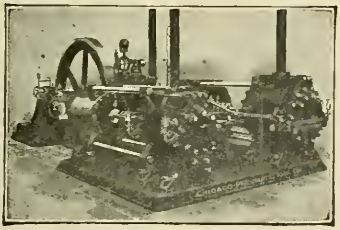

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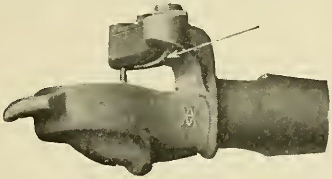

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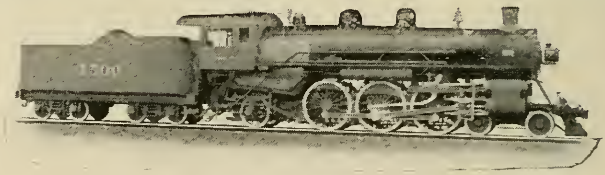

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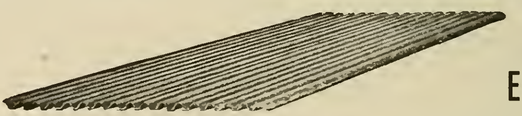

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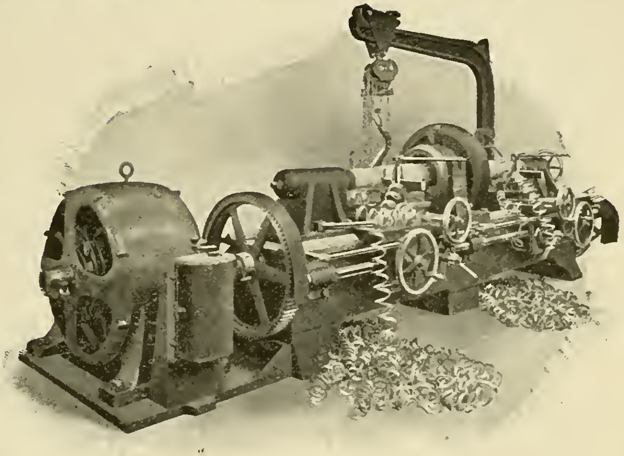

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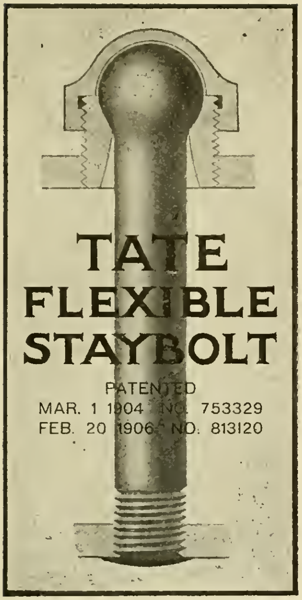

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Services of experts furnished free of charge to patrons interested in the economical use of oils.

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Binns, J. Y.
Blackall, R. H.
Chapin, E. S.
Chittenden, A. D.
Clark, C. C.
Colburn, Wm. W.
Courtney, D. C.
Cunningham, J. D.
Curtis, H. C.
Elmer, Wm.
Gearhart, J. A.
George, M. E.
Gilg, Henry F.
Good, H. J.
Grove, E. M.
Gutierrez, S. J.
Haas, Ben
Howe, D. M.
Huggans, J. H.
Imhoff, H. B.
Keyser, R. H.
Kluen, Richard
Kissinger, C. F.
Knickerbocker, A. C.
Koch, F.
Krause, Julius
Lindstrom, Chas. A.
Lobez, Pierre L.
Long, Robert
Lynn, Samuel
Malloy, M. A.
Maxson, H. W.
Metcalf, H. E.
Milliken, I. H.
McKeen, J. W.
McNulty, F. M.
Oliver, W. H.
Pechstein, Albert J. G.
Pfeil, John
Phelps, W. H. Jr.
Porter, H. V.
Postlethwaite, C. E.
Proven, John
Rhodes, P. L.
Robinson, S. R.
Ryan, W. F.
Schuchman, W. R.
Simpson, M. S.
Sims, David H.
Smith, A. D.
Smith, W.
Stark, F. H.
Stucki, A.
Sweeley, G. P.
Unger, J. S.
Warne, J. C.
Whited, Willis,
Wilson, Harry
Wood, Ralph C.
Wood, Walter B.
Woodworth, R. B.

VISITORS.

Albree, Chester B.
Archer, A. R.
Blackstock, J. A.
Clipp, Wilber L.
Dithrich, W. H.
Hoeffle, Geo.
Johnston, Guy S.
Jones, A. B.
Klingensmith, H.
Muchir, Edwin
McMahon, H. R.
Nelson, J. A.
Price, J. W.
Richmond, W. T.
Robbins, F. S.
Smith, Sion B.
Stephens, David
Wolff, C. E. Jr.

The reading of the minutes of the last meeting was dispensed with, same being in the hands of the printer.

The Secretary read the following list of applications for membership:

Berghane, A. L., Inspector, Westinghouse Air Brake Co., Pitcairn, Pa. Proposed by C. O. Dambach.

Delaplane, J. L., Storekeeper, Pressed Steel Car Co., 441 Jefferson Street, Bellevue, Pa. Proposed by H. E. Kaup.

Fedelman, F. E., Master Mechanic, Western Allegheny R. R., Kaylor, Pa. Proposed by A. W. Crouch.

Fullerton, A. W., Assistant Purchasing Agent, Westinghouse Machine Co., East Pittsburgh, Pa. Proposed by John Pfeil.

Hawk, Robert, Yard Master, Pennsylvania R. R. Co., 7524½ Hamilton Avenue, Pittsburgh, Pa. Proposed by R. H. Mackenzie.

Johnston, Guy S., Assistant Civil Engineer, Universal Portland Cement Co., 626 Lilly Avenue, Braddock, Pa. Proposed by Wm. W. Colburn.

Klingensmith, H., Traffic Department, H. J. Heinz Co., 123 Sycamore Street, Pittsburgh, Pa. Proposed by J. D. Conway.

Leonard, James, Jr., Clerk, Freight Train Master's Office, Pennsylvania R. R. Co., Union Station, Pittsburgh, Pa. Proposed by R. H. Maskenzie.

McIntuff, C. A., Salesman, Chicago Pneumatic Tool Co., 10 Wood Street, Pittsburgh, Pa. Proposed by H. S. Hunter.

Robbins, F. S., Assistant Master Mechanic, Monon. Div., Penna. R. R. Co., Thirty-second and Carson Streets, South Side, Pittsburgh, Pa. Proposed by A. W. Crouch.

Rys, C. F. W., Assistant Metallurgical Engineer, Carnegie Steel Co., Carnegie Building, Pittsburgh, Pa. Proposed by J. S. Unger.

Sanderson, M. W., Manager, Carborundum Co., Frick Annex. Pittsburgh, Pa. Proposed by D. J. Redding.

Warfield, J. M., Cashier and Chief Clerk, Universal Portland Cement Co., 216 Bessemer Avenue, East Pittsburgh, Pa. Proposed by Wm. W. Colburn.

Williams, Irving, Motive Power Inspector, Pennsylvania R. R. Co., P. O. Box 386, Altoona, Pa. Proposed by S. M. Hindman.

Wright, E. L., Rep., Collins & Wright, 5501-09 Butler Street, Pittsburgh, Pa. Proposed by John Freil.

SECOND VICE-PRESIDENT: As soon as these applications have been favorably passed upon by the Executive Committee the gentlemen will become members.

If there is no further business to come before the meeting, it is my pleasure to introduce the author of the paper of the evening, Mr. R. B. Woodworth, who will read his paper, the title of which is, "Tunnels, Particularly Subaqueous."

TUNNELS, PARTICULARLY SUBAQUEOUS.

BY MR. R. B. WOODWORTH, M. AM. SOC. C. E., AND ENGINEER WITH CARNEGIE STEEL COMPANY, PITTSBURGH.

A tunnel is a more or less horizontal underground passage constructed without the removal of the top soil. This definition, adapted from Sir Benjamin Baker's in the ninth edition of the Encyclopedia Britannica, excludes a few classes of construction commonly discussed as tunnels in the technical press. Under this definition a subway constructed by the cut and cover method is not a tunnel for the reason that while mining methods may be employed in the lower levels of the excavation, the structure is simply an open cut roofed over, either before or after the completion of the final excavation, and the operations incident to its construction have to do rather more with the proper support of adjacent buildings than with mining. Tunneling is essentially a mining operation and, therefore, the methods which are used in coal and metal mining, in shaft sinking, etc., are in general the methods which apply in tunneling through rock and soft material. The construction and maintenance of our large railway systems have contributed not a little to the development of tunnel practice. This development has, however, always gone hand in hand with coal and metal mining and the progress in one has been facilitated by experience gained in the other.

History: Nature is the great tunnel builder and caverns in limestone rock everywhere testify to her persistence and success. The Luray Caverns of Virginia and the Mammoth Cave of Kentucky have been chiseled out of solid limestone by the action of water in following joints, fissures, cleavage planes, etc., dissolving the rock by mechanical and chemical action and transporting it to enrich and fertilize farms hundreds of miles away. By this action streams of water are collected within vast underground drainage basins and gush from beneath mountains in mighty rivers; other rivers disappear under mountains to reappear again through tunnels as roaring torrents. The Sinks region in West Virginia is filled with instances of this character.

Man is an imitator of nature, and can well profit by nature's experience, because she has been longer engaged at this work and has had wider experience than any of her creatures. He, therefore, follows nature in planning his work along the lines of least resistance, in attacking rock work along the joints, cleavage planes and other lines of easy fracture and in assisting mechanical processes by the use of applied chemistry.

Man's first tunneling operations were in direct imitation of nature, as the headings which he drove and the underground chambers which he constructed were intended for purposes of self-preservation. Along the shores of the Swiss lakes he drove piles and planted his frail dwellings thereon; in France and England primitive man dwelt in caverns; in later days he constructed underground passages and chambers for his tombs and the abode of his gods, such as are seen in the rock temples of Nubia, India, etc. The first duty of a king of Egypt on his accession was to construct an underground dwelling for his sarcophagus, and mining methods had reached with them a high state of development long before Romulus founded his famous city. Catacombs were constructed in the Crimea, in Asia Minor, in Syria, Alexander and Malta, in Syracuse, in Sicily, Chiusi and Naples in Italy, and most widely and largely at Rome where the granular tufa forms a most admirable material for this purpose. They were first used for tombs, and during the persecutions, which began with Diocletian and extended down to the days of Constantine, preserved the lives of the Christians of Italy and the civilization for which they stood.

Man's ever present need for water appears also in primitive tunnel construction. In the days of Assyria's supremacy a brick arched tunnel was constructed under the Euphrates River 12 feet high and 15 feet wide by the method of stream diversion. This is probably the most early example of subfluvial tunnel construction. The chronicler of ancient Hebrew history in his discussion of the deeds of Hezekiah has not forgotten to mention his great claim on posterity in the building of a tunnel to carry the waters of Gihon from without the city walls to the Pool of Siloam. This tunnel was 1707 feet long driven by headings from each end, which met 944 feet from the Siloam entrance; and what is probably the oldest Hebrew inscription is the contemporary record inscribed by the masons 25 feet from the entrance which tells us that "On the day of the piercing through the miners smote each so as to meet his fellow—pick against pick," an indication not only of tunneling methods but of experience in engineering works of which today many of us are not aware. In Seleucia, not far from a natural tunnel, a river flows through a tunnel 20 feet wide and 23 feet high, cut 1600 years ago through rock so hard that the chisel marks are still plainly visible.

The Romans were great tunnel builders and wherever their famous transportation lines extended throughout the length and breadth of the empire the well constructed roads were marked by sewer works, excellent drainage and rock tunnels, while their famous aqueducts speak of wide experience in engineering. Pliny tells us of a drainage tunnel to Lake Fucino which was the greatest public work of his time, passing 3½ miles under Mt. Salviano. This tunnel was about 10 feet high and 6 feet wide and constructed from 40 shafts, some of which were 400 feet deep. Its building required the services of 30,000 men for 11 years, whereas in modern times with machine methods the same tunnel would have been constructed from headings run from both ends in 11 months.

The Middle Ages did not advance very far beyond the methods employed by the ancient Romans. The invention of gunpowder added somewhat to the facility with which tunnels might be constructed, but rapid improvement in tunnel methods and practice had to wait for the introduction of improved methods of transportation and above all specialized machinery. Modern tunnel practice dates from 1800, but has not yet reached its full development. We still need specialized boring and drilling machinery and applied uses of electricity for operation and transportation, and somewhat to the shame of our expert American miners it may be said that Europe holds the record for high tunnel performance.

CLASSIFICATION OF TUNNELS: A rational classification of tunnels is not a very simple matter. They might be classified in accordance with the purpose for which they are used into steam railway tunnels, subways, sewer tunnels, intake tunnels, drainage tunnels, mine headings, etc., but a classification on this basis would not be of any more value than if they were classified into straight, curved or crooked, or into large, medium and small. It being premised all the time that tunneling is essentially a mining operation, a rational classification appears to be rightly based on the classes of material through which they penetrate, as after all that is the essential feature in the method of attack and the character of the equipment required for their construction. These materials are rock, rock and earth and all earth, and these three classes may also be divided as to the presence or absence of water bearing strata. Where there are water bearing strata the use of compressed air may or may not be necessary, which would compel a further subdivision, making in all nine classes of operations, each calling for the solution of special problems.

Again, tunnels through water bearing strata are likewise subject to different conditions as to whether the water comes from the sides of the excavation or from above. In tunnels under streets and in many railroad operations the water may be confined to such as percolates through the sides where its pressure is comparatively light. Tunnels may be built under bodies of water, becoming subaqueous in deed and truth, and may penetrate through all rock, part rock and earth and all earth, and may be driven in such subaqueous conditions by the use of a shield with compressed air or without compressed air, also without a shield with compressed air and without compressed air. Problems of various kinds will arise conditioned on whether or not the rock covering is stable and thick or whether it is fissured, broken or thin. The material above the rock is also an element of some concern.

In the construction of an extensive railway terminal system it is possible that materials of all these kinds will be encountered and that all the various methods of construction might be called into play at some point of the operation, and indeed in a tunnel through a hill the excavation might pass from earth through earth and rock to solid rock. In this condition, however, the ordinary practice is to excavate the approaches to the tunnel by the open cut method and to use mining methods only after the portals have been passed. For the purposes of this paper, however, a rational classification of tunnels will be into rock, soft ground and subaqueous in accordance with the following detailed definitions:

1. ROCK TUNNEL. A more or less horizontal underground passage driven through stable material by the ordinary mining methods of drilling and blasting with or without timbering or lining, where such water as may penetrate through the material can be taken care of by within tunnel drainage.

2. SOFT GROUND TUNNEL. A more or less horizontal underground passage driven through yielding material by ordinary mining methods of excavation with or without a shield and at normal or low air pressures, water percolation under gravity head being disposed of by within tunnel drainage.

3. SUBAQUEOUS TUNNEL. A more or less horizontal underground passage driven under a body of water through yielding material by ordinary mining methods of excavation with or without a shield at high air pressures against hydrostatic head, ingress of water being prevented more or less absolutely.

These definitions are based on the distinction between mining methods of blasting and excavation and ordinary open cut methods and, therefore, treat the whole system of tunneling as a branch of the art of mining. They are strictly in line with the definition adopted for a tunnel at the outset. If, however, it is maintained that a subway excavated under city streets or elsewhere by the open cut and cover method is to be looked upon from the standpoint of the completed work as distinguished from the methods involved in its construction, then we may have a fourth class of tunnels, viz.:

4. Open cut tunnel. A more or less horizontal underground passage driven through hard or soft materials by ordinary methods of excavation and covered by a flat or curved roof after the excavation is completed.

It is apparent that a tunnel shaft may be driven through soft or hard materials with or without lining by mining methods, but an essential feature of the designation tunnel is its more or less horizontal character.

Rock tunnels: The rock tunnel is the simplest application of the methods of mining to the construction of underground passages and modern advances have been due not to any radical change in the methods of attack but to the introduction of high explosives, power drills driven by steam or compressed air and modern methods of transportation with electricity or compressed air.

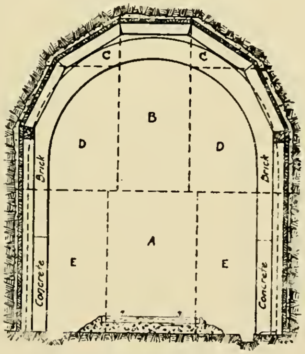


Figure 1.

Methods of attack. Mining methods reflect to a large degree national characteristics. In England mine shafts are usually circular; in the United States almost always rectangular; in England long wall methods are common; in the United States almost unknown. These differences are due in part to natural conditions and in part to diverse experience and more or less familiarity with machine methods; consequently the differences which exist in the art of mining exist also in the branch of tunneling. Fig. 1 shows a typical design of a single track railroad tunnel driven through rock and lined with brick supported on concrete side walls. It is subdivided into sections lettered to correspond with various methods in which material is removed. Tunnel excavation usually begins by the driving of a heading either at the top or bottom of the excavation.

In the Austrian or drift method of excavation the heading is driven at the bottom of the tunnel through section A, track laid for mine cars and advanced some distance ahead of the full section excavation. This advance heading is followed by the removal of sections B, C, D and E in their respective order, and if invert is to be made below the general level of the tunnel, it is completed as a final excavation.

The German method is to begin with the top heading through section B and to follow with C and D, completing the excavation down to a level and leaving a bench extending the entire width of the tunnel. This bench is then next attacked by two side headings in the bottom through E, leaving a firm central pillar A to be removed at the completion of the cross section excavation, but permitting mine cars to be run on each side thereof for prompt removal of material.

In soft ground the German method is to drive side headings at the bottom of E, which are usually subdivided into three parts and removed in successive layers by caving into the cars below. After both lower side sections E have been removed, a top heading is driven through B to be followed in turn by the excavation of C and D. During the progress of this excavation the lining of the tunnel is put in and the timbering erected thereon, leaving the solid central pillar A to be removed, as in the German method of rock excavation.

The English system is to drive a top heading in B from which sections C are excavated and crown bar timbering placed. A heading is then driven in the bottom of A and excavation proceeds, as in the Austrian or drift method, by the removal of the lower part of D sections as a bench and the excavation of top of A and the side sections E.

The Belgium method is to drive a top heading likewise and to excavate side sections C and D down to the level, timbering by the crown bar method as in English practice. The central section A is then removed to be followed in turn by the lower side sections E.

The American method, if any exclusive system may be designated by that name, has ordinarily been to divide the tunnel into three transverse benches and to remove them in order from the top down by taking out, viz., the side sections C, the top of B, the lower portion of B, the side sections D and the lower sections A and E; thus in a measure applying to tunnel work methods which are more common in open cut excavation.

The indications are that the most economical method of tunnel construction is the Austrian or drift method which drives a bottom heading first and permits the construction and maintenance of a transportation system in proper position for constant use without the necessity of track removal. A miner also in mining coal in successive levels works always to the heading below, shoveling his material downhill wherever possible.

Driving records. The interest in speed records in rock tunneling is due to the fact that the time needed to complete the entire tunnel, and consequently the period during which vested capital lies idle, is wholly dependent on the speed with which two small headings can be put forward; only a small party of men can work in each heading and concentration of working forces is not possible; therefore, engineering construction looks upon speed of work in tunnel driving as an item of supreme importance. High efficiency of tools and methods and careful attention to the prevention of delays of whatever character are the main features in the determination of tunnel progress. Natural conditions may, of course, affect the work, such as unfavorable direction of strata, fissured rock, presence of water, etc. Where the rock is firm, solid and dry, one month's work may be double the ordinary rate of advance. The record for high tunnel driving is now held by the Alpine tunnels, such as the Simplon, the Arlberg and the Loetschberg. The greater length of these tunnels and the possibility of installing a more perfect plant and a more thorough organization may account in some measure for the comparative supremacy over English and American records. A few of these may be worth our attention, it being remembered all the time that the kind of rock, its hardness and specific gravity, the presence of joints, seams, cleavage planes or other lines of structural weakness, and the size of the heading itself, are elements of large importance in any comparison.

The Joker Drainage Tunnel, Red Mountain, Col., 5055 feet long, was driven 282 feet in its best month, July, 1904, through Andesite breccia. The heading was 12 feet by 11 feet timbered 8′ 6″ by 7′ 0″. Drilling was done with water Leyner drills and material was mucked by men in iron cars hauled by mules, though later transportation was effected by twelve electric locomotives.

The drainage tunnel at the Iron Mountain Mine, Superior. Mont., 5853 feet long, was driven in 7′x6′ heading through quartzite 288 feet in one month, January, 1907. Average rate for the entire tunnel 233 feet per month. Cost per foot, $14.50.

The 6′x9′ heading of the Newhouse Drainage Tunnel, Idaho Springs, Col., 22000 feet long, was driven 290 feet in May, 1906, through granite and gneiss.

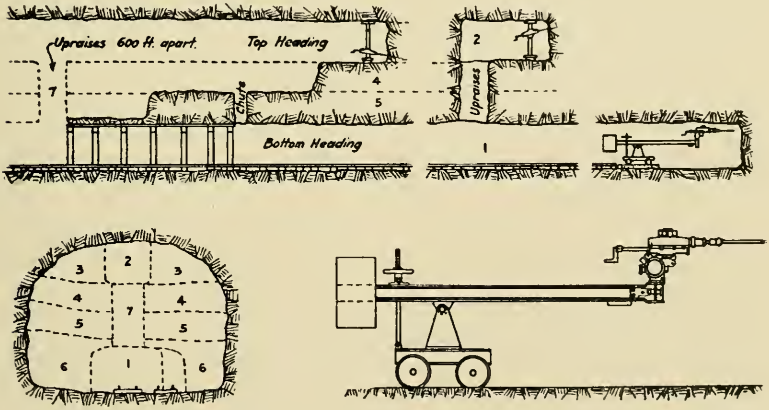
The best progress made in the construction of the Roosevelt Drainage Tunnel at Cripple Creek, Col., 15550 feet long, was 435 feet in January, 1909. Average monthly advance for twelve months 292 feet. The heading 10 feet wide by 6 feet high with a 3′x6′ drainage ditch on one side of the floor, was driven through Pikes Peak granite by water Leyner drills, No. 9, mounted on a horizontal cross bar wedged against the sides of the bore, two drills being operated in each heading. The muck was taken out in steel cars of 36 cubic feet capacity on a single track railway in trains of 10 to 12 cars hauled by mules.

The Gunnison Tunnel, an essential part of the Uncompahgre Valley reclamation project, is the longest irrigation tunnel in the world. It is 30582 feet in length and the headings were driven to a meeting point on July 6, 1909, as the culmination of 54 months' continuous work. The best record made was the driving of an 8′x12′ heading 842 feet in one month in soft shale. The best record in granite for any single month for one heading was 449 feet, January, 1908. In the hard granites the Sullivan 3″ piston drill was used; in less refractory ground Sullivan 2½" drill; in the shales the Jeffrey coal auger, air driven, was used with highly satisfactory results; the Leyner drill was also used in certain classes of the work. The record headings were driven by the under-cut method.

The Elizabeth Tunnel of the Los Angeles Water Works, California, 26860 feet long, was driven 466 feet in granite in October, 1908. The heading 12'x12' was driven with a model 6-A water Leyner drill, the mucking being done by hand and the tramming by electric motors. Cost per foot, $31.81.

An excellent record in driving a railroad tunnel was made in 1908 on the Bitter Root Tunnel of the Chicago, Milwaukee & St. Paul Railroad, through the Bitter Root Mountains, Montana. The tunnel was driven by the regular top heading method and was advanced 563.5 feet in May of 1908, the average advance for the three months of March, April and May being 499.7 feet. The rock is a quartzite somewhat laminated and the heading is the full roof arched section for a double track tunnel.

The new Croton Aqueduct has a length of 30.87 miles, of which 29.63 miles is in tunnel, being horseshoe in form, 13.53 feet high and 13.6 feet wide and carrying an estimated capacity of 318,000,000 gallons of water per day. This is the longest tun-



Loetschberg Tunnel Methods

Figure 2.

nel in the world. It was driven from shafts about a mile and a quarter apart along the length of the line, and the best record in any one heading was 550 feet per month. This was in hard rock in an unusually large heading and the ordinary progress was about 175 feet per month.

Fig. 2 shows the method of attack and the sequence of operation in driving the south heading of the Loetschberg Tunnel, which is being built in Switzerland on the line of the railway to connect Berne with the Simplon Tunnel route to Italy. This tunnel when completed will be about 8½ miles long. The bottom heading 6′ 6″ high by 10 feet wide is driven by machine drills mounted on drill carriages, and the rock encountered varies from granite to gneiss and is hard drilling. Compressed air is furnished by two electrically driven Ingersoll Rand compressors of the cross compound two stage type. The record in this tunnel is 574 feet in September, 1907. Average speed for five months, 555 feet per month.

A record of 579 feet during the month of May, 1909, has been made in the Fernando Tunnel, located about 25 miles north of Los Angeles and driven in connection with the construction of the Los Angeles intake through soft sandstone. The tunnel has a section of 10′ 8″x11′ 2″, and the whole section is carried forward in one operation by three shifts of sixteen men each. The completed tunnel will be 9112 feet long.

The Arlberg Tunnel, in the Alps, 33696 feet long, was advanced through schist and gneiss 641 feet in July, 1883, by the use of Brandt rotary drills. The average speed of driving for 40 months was over 400 feet per month.

The world's record for rapid tunnel driving is held by the Simplon Tunnel, 64818 feet in length, in the construction of which a heading 6′ 6″x9′ 8″ was driven through schist and gneiss 755 feet. This figure was made in July, 1904, in the south heading, the best speed in the north heading being made in December, 1902, at the rate of 682.2 feet. In both headings the work was interrupted and delayed by bad rock, the average rate of speed of 426 feet per month for 76 months being exceedingly good.

If now we compare these records with that of the Hoosac Tunnel, 4⅔ miles long, driven in 1865-1873, it will be noted at once how great the improvements have been in tunnel methods. The best record of the Hoosac Tunnel was 184 feet per month with machine drilling. It will also be noted how far short we come of the best European records, the secret of which appears to be that a very careful study has been made of the various causes of delay in the successive processes of drilling, blasting, mucking out and setting up the drills again, with the result that a radically different method of mounting the drills in the heading has been employed and also a different system of blasting used from that practiced in the United States.

Fig. 2 shows that the bottom heading in the Loetschberg Tunnel, on which the speed of the tunnel depends, is driven by a machine drill mounted on its own separate drill carriage, which permits the speediest possible removal for blasting and renewal of work after blasting is over. This bottom heading is supplemented by the regular pneumatic drills in the other headings which blast material down into the bottom for speedy removal. Excavators have been invented and used to some extent in the United States. The Jackson Tunneling Machine, described in Engineering News for February 22, 1908, is intended rather for use in clay. The Mersey Tunnel, however, was bored in part with a Beaumont Machine cutting to a diameter of 7′ 6″, and doubtless we have not yet come to the full development possible in the way of multiple drills and drilling machines.

Lining. However stable the rock may be, very few tunnels are now allowed to stand without some form of lining, as the best rock is liable to swell and to fall, making track maintenance more difficult. In the olden days timber lining was common and has not yet entirely gone out of fashion in such sections as there is still a supply of good timber close at hand. The Bitter Root Tunnel of the Chicago, Milwaukee & St. Paul Railroad is lined with timber made up of 12″x12″ longitudinal sills and wall plates with 16-foot posts and a five-segment arched rib spaced according to the character of the material to be supported, usually 3 to 4 feet center to center, but in many cases the material necessitated putting the timber closer together. 2″ lagging is used on the side of the tunnel and 4″ on the arch.

There is always in a timber lined tunnel danger of fire from locomotives, and the same considerations which seem to forbid the presence of timber in mine shafts apply as well to its use as a permanent tunnel lining material, consequently it has been to a large extent superseded by brick. The Mt. Washington Tunnel, of the Pittsburgh Railways Company, is a very good example of a two-track brick lined tunnel driven through stable material. Water works tunnels are to a large extent lined with brick, a most noteworthy example of which is the land tunnel for the new water works, Cincinnati, Ohio, constructed in 1903. This tunnel is 22264 feet long and carries treated water from the shaft at the clear water reservoir to that of the city pumping station. It is 7 feet in diameter in the clear and 9′ 6″ over all, and is lined with two rings of specially made radial pressed vitrified shale brick laid with close joints and backed with concrete, the minimum thickness of the concrete being 6″. Where the tunnel passes beneath the Little Miami River the lining is reinforced by rings of ¾″ round steel bars 2 feet center to center. The tunnel was driven through limestone and shale rock and the few streams of water encountered were taken care of by driving pipes into the seams so as to discharge the water within the tunnel.

The Raton Hill Tunnel, of the Atchison, Topeka & Santa Fe Railroad, at Raton Pass, on the Colorado State line, built in 1908, 2790 feet in length, is lined with reinforced concrete varying in thickness from 2½ feet at the base to 2 feet at the springing line of the arch. The arch ring also has a thickness of 2 feet. These dimensions apply to soft ground. In loose rock the thickness is 2 feet at the base, 18″ at the spring line and 18″ in the arch ring. Irregularities between the excavation and the outside limits of the concrete were filled with loose stone packing laid by hand.

The Bergen Hill Tunnel, of the Lackawanna Railroad, is likewise lined with concrete and the rails of the double track are carried on concrete laid on the rock bottom of the tunnel. The concrete tunnel lining is two feet in thickness.

The Gunnison Tunnel is a timber lined tunnel with a concrete facing, but differs quite a good deal from ordinary railroad tunnels in the fact that the tunnel itself is intended as an aqueduct and the tunnel lining forms a flume for the passage of the water. This flume is built in the ordinary manner with timber sets three feet center to center lagged with planking and wedged tightly against the excavation by cord wood. The whole wooden structure is filled within with concrete to the finished dimensions, thus providing a structure of maximum resistance to stress and of a waterproof character.

The tunnel profile shown in Fig. 1 is drawn after that of the Langsville Tunnel of the Kanawha & Michigan Railroad, and the permanent lining consists of a reinforced concrete wall eight feet high on each side, with brick masonry above and with brick arch. The reinforcement of the side walls consists of old rails and truss rods from old cars. The rails were set in holes drilled in the bottom of the tunnel and built into the brick walls above, thoroughly tying the brick work, concrete and tunnel floor together. After the reinforcement and forms were in place the concrete was mixed in a Smith mixer run by compressed air and mounted on an ordinary flat car, and was dumped from the car directly into the forms of the walls. The bricks were laid with Portland cement mortar with as thin joints as possible, the harder burned bricks being selected for the exposed courses.

The Duluth Tunnel, of the Wisconsin Central Railroad, is lined with an arch and side walls of concrete, which is mixed in the proportions of one part Universal Portland cement, three parts bank sand and five parts gravel, mixed in a one-yard Smith mixer. Flat cars were operated from a narrow gauge track laid on the cross braces between the wall plates and the tunnel timber. A short piece of track was laid on the deck of each of these cars to carry a small hopper car in which the concrete was transported, which permitted the delivery of the concrete directly to the top of the wall forms. The concrete for the arch was shoveled into place from the cars.

The concrete used in the lining of these tunnels was put in place by the use of ordinary removable wooden forms. Modern methods for the mixing and placing of concrete by the use of removable steel forms are to be seen in the Blue Island Avenue Tunnel, City of Chicago, constructed under the supervision of Mr. George W. Jackson, President and Chief Engineer of George

W. Jackson Company, Inc. The Jackson lagging ribs are built of 5″ 9 lb. channels bent to the radius of the circle required to bring the lagging to the proper curve, with the flanges of the channels out. Each rib is made of four sections, each section being a 90-degree arc of a circle, the inside diameter of the tunnel being 8 feet. The lagging used with these ribs consists of 3-foot lengths of ¼″ plates 12″ wide. These plates have a light steel angle riveted along both sides and both ends so as to form a rim entirely around the plate flush with the edges of the latter. The angles on the sides of the plates are notched to fit over the flanges of the channels of the ribs, which can thus be spaced accurately by placing a few of the lagging sections. At the same time the joints between the edges of the adjacent sections of lagging can be made quite smooth and tight enough to hold concrete. As fast as the mining is carried ahead of the finished tunnel lining, the concrete in the lowest part of the invert is generally placed to provide for the erection of the steel lagging ribs. When the ribs are placed, the lagging for the lower part of the circle is set and the invert lining finished up part way on each side. The spoil-car track and shoveling platforms can then be laid on cross ties formed of a horizontal angle attached to each lagging rib, and the concrete lining can be completed at leisure. After the concrete is set the removal of the form is very readily accomplished by simply loosening the bolts at the top and side joints of the lagging ribs and by knocking out the wedges. The forms are then carried ahead and re-erected, only a sufficient amount of steel ribs for lagging being provided in each heading to permit the concrete to set the required time. That these forms are practically indestructible under service is indicated by the fact that upward of a half mile of concrete tunnel lining has been placed with each set of them in use.

The same method of removable steel forms has also been used in the construction of the Southwest Water Tunnel in Chicago, likewise built by George W. Jackson Conpany, Inc. While the Blue Island Tunnel was 8 feet inside diameter, the Southwest Water Tunnel is horseshoe shape in cross section of variable dimensions equivalent at different points to 12, 14 and 16-foot circles. In this instance the lagging ribs were 6″ channels. This form of interlocking steel ribs, or some similar method of construction, will doubtless reduce very materially the cost of concrete lining; so also will doubtless the use of the Telescopic Collapsible Steel Form and Traveler, manufactured by the Ransome Concrete Machinery Company, and described in the October 2, 1909, issue of the Engineering Record.

Reinforced concrete commends itself for rock tunnel lining. Whether or not it will eventually replace brick for such purposes will depend on its performance in recent installations. What form the reinforcement will take will depend largely on circumstances, but the reinforcement should always be designed to increase materially the strength of the concrete and be in such form as to perform the most service for the least weight. In the construction of the Aspen Tunnel, of the Union Pacific Railroad, in Wyoming, unexpected difficulties were encountered. A double track tunnel was driven by the ordinary American method of taking out and timbering the top third of the excavation and the benches were removed by the use of the steam shovel. The material through which the tunnel penetrated was exceedingly unstable, being a disintegrated soft shale rock. Here slips were

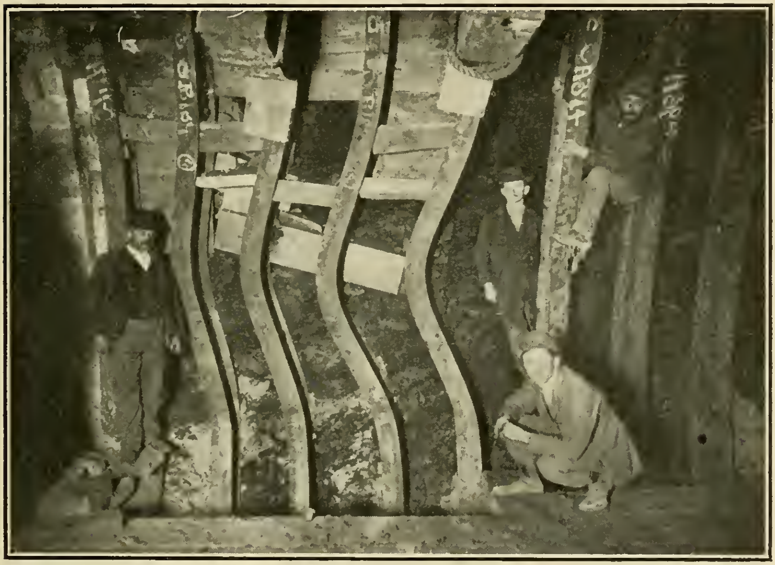


Figure 3.

frequent and heavy timbering was used to overcome the tendency of the whole mountain to slide into the excavation. When heavy timbers proved too light, 12″ 31.5 lb. beams bent to the curve of the tunnel and erected in three sections spliced together were tried. These also proved too light for the work and many of them were seriously bent and twisted under the tremendous earth pressure, as shown in Fig. 3. The settlement was finally stopped and the tunnel completed by the use of 12″ 55 lb. I-beam rings spaced two feet center to center and filled in solid by concrete, as shown in Fig. 4. Inasmuch as steel mine timbers, in more or less similar form, have been found highly satisfactory in coal mining operations in this country and abroad, there seems to be no reason whatever to prevent their similar use in standard railroad tunnel construction where heavy loads are to be sustained and where the ordinary methods of timbering appear likely to prove inadequate.

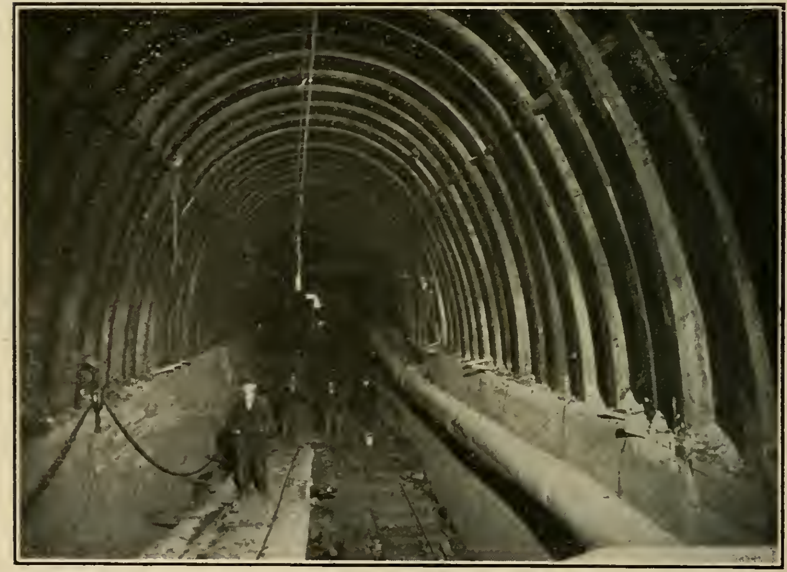


Figure 4.

Soft ground tunnels: The essential differences between a rock tunnel and a soft ground tunnel is that the former is drilled and blasted while the latter is bored and dug; machine drills give place to augers, and timbering common in stable ground is replaced by the fore-poling method of construction. If the ground contains no water and danger of subsidence is small, the timbering necessary is reducible practically to the amount required properly to support the excavation during the process of lining. If, however, the material contains water and the excavation is carried on at shallow depth in close proximity to buildings, the use of a shield may be found desirable, and so also may the use of compressed air at a low pressure, ordinarily ranging up to 8 or 9 pounds above normal.

The largest system of soft ground tunnels in the world is the network built by the Illinois Telephone & Telegraph Company below the streets of Chicago which now extend 66 miles. These were first built for telephone and telegraph cable conduits and have been later extended to carry a narrow gauge transportation system for freight traffic. The tunnels, of a horseshoe form 6′ wide and 7′ 6″ high inside dimensions, are constructed of concrete 10″ thick on the crown and sides and 13″ at the bottom. The method of construction was as follows:

The bore was dug in the clay for a distance of 20 feet and about a foot larger all around than the completed tunnel. The 13″ concrete bottom was then put in place and upon this were placed forms made of 5″ channel bars in two pieces, curved to the exact size of the inside of the completed tunnel. Outside of these forms boards 20 feet long were placed, one at a time, on each side and the concrete rammed into the space between the boards and the clay. When the crown forming the key was reached boards 3 feet long were used. It was afterwards found better to build 15-foot sections instead of 20-foot. The concrete was composed of one part Portland cement, three parts sand and five parts gravel.

The tunnels were commenced in September, 1901, and were driven in stiff blue clay containing very little water, but occasional pockets of gas and quicksand were encountered. As a precaution the work was all done on the pneumatic system, the air pressure being about nine pounds per square inch. The material was excavated with spades and drawknives and hauled away in small cars 20″x48″ inside measurement. The main tunnels are built at a depth of about 20 feet from the street surface to the crown tunnel. As they are located under the center line of the street, they are clear of the lines of pressure from the buildings and are subject only to the pressure due to the overlying material. The work, therefore, is delicate in its nature, but with the low air pressure there has been practically no trouble from settlement of the ground; where driven without air small subsidence has sometimes occurred.

The intake tunnel of the Municipal Water Works of Gary, Ind., built 1908-09, is likewise an example of the soft ground tunnel driven without shields. This tunnel has a horseshoe shaped cross section equivalent to a 6-foot circle and a total length of approximately 15000 feet. It is being driven through the thick stratum of clay underlying Lake Michigan and at a depth of about 20 to 30 feet above bed rock. A section of tunnel about 225 feet long was first driven from the bottom of the pump shaft and lined without the use of compressed air in the heading. An air lock was then installed at this point and since then all the operations in the heading have been handled under air pressure. The work in the heading is prosecuted by three 8-hour shifts of laborers. The mining is done by two shifts which advance the heading 24 to 27 feet under normal conditions, and the concrete lining for the bore of the tunnel is placed by the third shift, so that 24 to 27 feet of lined tunnel are completed every 24 hours. The most of the clay removed is of such a nature that it can be cut with a draw-knife, although sharp spades and adzes are occasionally used. The excavation is not timbered as it progresses since an air pressure of 12 to 16 pounds is sufficient to maintain the shape of the bore until the concrete lining can be placed. The forms for the concrete lining consist of pieces of 3″ wooden lagging 3 feet long, which are held in place by tee iron ribs bent to the horseshoe shape of the tunnel cross section. These ribs are spaced 3 feet apart on centers and are made in three pieces to permit of ready removal.

The Baltimore Belt Tunnel, Baltimore, Md., 1.4 miles long, is a double track tunnel through sand and clay, built by the crown bar method of timbering in 1890-1893, and is notable on account of an attempt to carry forward the excavation by means of a roof shield running on side walls constructed previously.

The construction of tunnels by this half shield method proved successful in 1896 on a portion of the Boston Subway under Tremont Street and the system has had rather wide application. The shield weighed about 22 tons and was calculated to sustain an approximate load of 640000 pounds; was 29′ 4″ wide over all, with a rise of 4′ 4 5-16″ and was composed of two plate girders 3′ 8″ deep and 4 feet apart with cover plates extending 4″-0″ beyond the girder, while an additional top plate extended 2 feet in the rear. Under each foot of each girder was an iron casting which fitted into a recess in the cast steel shoe. These shoes rested upon two lines of 10″ steel I-beams imbedded in the concrete side walls forming the track upon which the roof shield slid as it was pushed along. The shield was propelled by ten 6″ hydraulic jacks located around its upper portion. The outer ends of the plungers were fitted with collars which abutted upon 2¼″ cast iron round bars built into the brickwork of the arch and forming continuous lines of metal to resist the thrust of the jacks. This device was apparently first used by Mr. Walter I. Aims in the East River gas tunnel at New York City. As soon as the shield had been pushed forward about 3 feet the timber centering was erected behind it and the brick arch lining of the tunnel built. During this time a heading 6 feet high and the whole width of the tunnel was excavated ahead of the shield and supported by posts and poling boards, which were removed as the the shield reached them. The material was mainly gravel and stiff clay. The depth of earth above the tunnel varied from 6′ 9″ to 13 feet and a progress of about 50 feet per week was made. The two side walls were built in advance headings. The arch was built by means of the shield and the center core of material removed later.

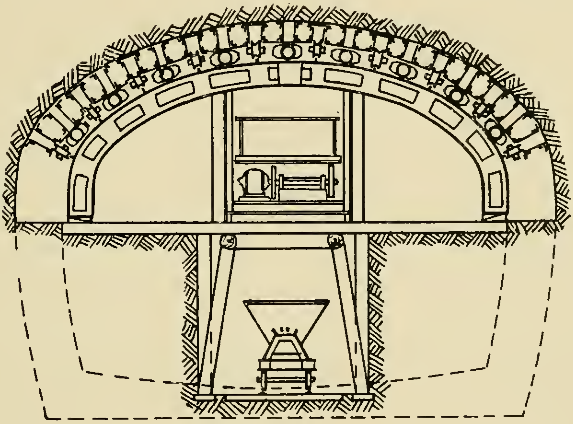
The half shield method has also been employed in 1908 in the construction of the intake tunnel of the Lawrence Avenue Pumping Station, Chicago, Ill., 1446 feet long. This tunnel is used in conection with the intercepting sewerage system of Chicago for furnishing water from Lake Michigan for dilution of the sewage and is believed to have the largest cross section of any that has been built for similar purposes. It has a full center arch with a span of 20½ feet with a rise of 8′ 11″. The bottom is an inverted flat arch so that the total height of the structure at the center line is 14 feet. The cross sectional area is slightly more than equivalent to a 16-foot circle.

The cover between the crown of the arch and the bottom of the lake varies from 18 feet at the outer end of the tunnel, where it is made up of 4 feet of sand at the top and the remainder clay, to 34 feet at the shore shaft. The upper part of the bed of clay is of a soft blue character which increases in stiffness with the depth, so that the invert and the bench walls of the arch of the tunnel are founded on hardpan. Owing to the large area of cross section it was considered impracticable to make the whole bore at one operation. The plan was, therefore, adopted of driving two headings, each 7 feet high, 6 feet wide at the top and 9 feet wide at the base, for the bench walls of the arch and of building these walls in advance of the removal of the core of the excavation and the completion of the balance of the tunnel. The drifts were excavated by hand with draw-knives, adzes and similar tools without air pressure, though they had to be lined closely with bents of 8″x10″ timbers.

The shield used in driving the main tunnel excavation was built up of steel plates and structural shapes and conformed in outline to the arch of the tunnel. It traveled on rails laid on the bench walls of the arch built of concrete in the advance headings. The shield was five feet long with a projecting cutting edge around its rim at the front end and was braced apart at the bottom by a horizontal steel platform carried by five 10″ 40 lb. I-beams. A heavy plate on the botom of each side of the shell of the shield rested directly on a pair of rails on timbers carried by the corresponding bench wall. The shield was advanced by means of twelve 6″ hydraulic jacks equally distributed around the periphery of its shell. The work was carried on under an air pressure of 8 pounds as an insurance against difficulty and the regular sequence of operation was as follows:

First the concrete bench walls were built ahead 150 to 200 feet in the side headings. When the concrete had set the shield was pushed ahead with its own jacks which re-acted against the timber lining of the excavation. This lining consisted of segments in 3 and 4-foot lengths cut from 7″x10″ oak timbers and was placed immediately following the shield to retain the soft bulging clay through which the greater part of the tunnel is built. The brick arch was constructed in sections 22 feet long from a timber traveler of that length which operated on rollers on timber laid on the hardpan. After the arch work was built the excavating and concreting of the invert were completed.

The latest practice by French engineers in shield construction is shown in Fig. 5, which is a cross section of a tunnel with the shield in place used in the construction of the Metropolitan Railway, Paris. The roof of the Metropolitan Railway Tunnel is but little below the surface of the street and the tunnel is a double track structure with a clear span of 23.29 feet and with a rise of 6.79 feet in the arch. The arch abutments and floor are all of masonry. The first portion of this tunnel was constructed in 1898 with a half section shield on which the arch was built and the abutments constructed last, but the results were not satisfactory and the failure of the shield was largely due to the fact that the soil penetrated was not homogeneous. Then, too, in moving forward the shield carried with it around its outer surface a certain thickness of earth which caused undulations on the surface ground and by its broken condition threw too much



Metropolitan Railway Tunnel
Paris, France.

Figure 5.

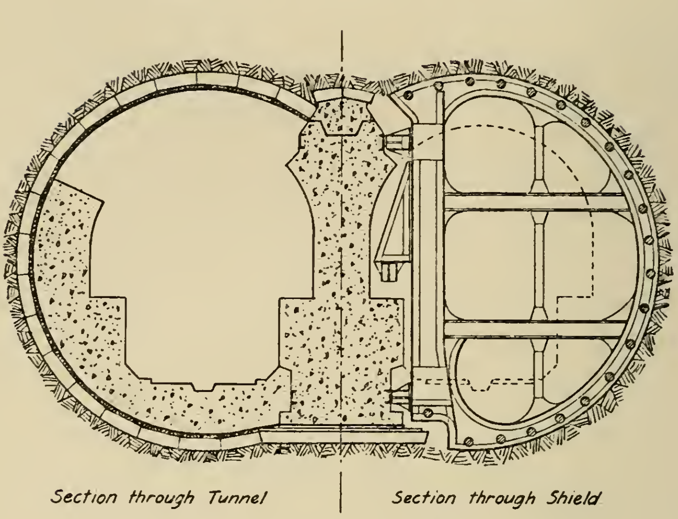
weight on the tail end of the shield. There was thus a tendency in the shield to rise at the forward end, while the fresh arch masonry was damaged under the friction of the shield when it was moved forward.

The characteristics of the new roof shield designed by the engineers Radenac and Raguet to avoid these troubles were its length and the more stable support provided for the shield rollers when the shield moved forward. In actual use the shield has been advanced as much as 20 feet in 24 hours. The shield was made of an outer steel shell shaped with the extrados of the arch and its total length was 24′ 6″. This shell was supported by four cross beams connected by 38 longitudinal girders, of which 20 extended forward to support the front end and 18 carried on rear end. The webs of the girders were stiffened with angle iron, making a beam box of each pair of girders. Ten of these box beams supported the rollers on which the shield was moved and nine of them carried the hydraulic jacks. The total weight of the shield and its framework was 34 tons. The steel cutters on the front of the hood were eight in number. The rollers were not operated on top of freshly laid masonry, but traveled on steel centers which were built of beams shaped to the arch and divided into two equal parts connected by bolts. The foot of this center extended about 18″ below the spring of the arch and rested upon a cross tie made of two steel plates and angles. This tie obviated the tendency in the center to spread and the whole center was carried on longitudinal sills supported by posts driven in the undisturbed ground of the lower advance gallery. The movement of the shield over these centers was very steady and the surface undulations did not exceed 3″. The hydraulic jacks were 8′ 8″ long and had a stroke of 3′ 7″. They were fastened to the shell of the framework and their pistons acted upon thrust blocks set between the center ribs. As these ribs were theoretically immovable, the shield shell and its framework advanced. As the shield moved forward, sheets of thin steel replaced it to prevent the earth from falling in. These plates were held in place by temporary timbering until the masonry was completed, the plates remaining in the ground. The masonry was built on wooden lagging laid on the steel centers.

The most recent example of the half shield method of construction in soft soil is to be found in the construction of the Detroit River Tunnel, of the Michigan Central Railroad, now building. The total length of this tunnel is 12800 feet, made up of 1540 feet open cut, Detroit end, 2135 feet approach tunnel, Detroit end, 2625 feet subaqueous, 3100 feet approach tunnel, Canadian end, and 3400 feet open cut, Canadian end. The cross section of the approach tunnels on both sides of the river is practically the same, each consisting of two single track structures with a vertical wall 4 feet thick between. The roof of each half of these structures is a full center arch 2 feet thick on the American side and 2′ 6″ thick on the Canadian side with an inside radius of 8′ 3″ and a clear height of 18 feet above head of rail. Owing to the great extent of the excavation required it was realized that in the event it became necessary to handle the excavation by the shield method operating either in the open or under pneumatic pressure, a shield large enough to permit the twin tunnels to be built simultaneously would be impracticable. The decision was, therefore, made to run a drift of sufficient cross section to permit the construction within its limits of the common center wall, and after this wall had been placed, to start the heading of the twin tunnels, thus utilizing the massive core of concrete both as a guide and as a basis for the excavating and concrete work to follow.

The 10′ 5″x14′ center headings were carried through on the Detroit side without the use of air pressure, but all the work was heavily timbered as rapidly as the headings advanced. On the Canadian side difficulties were encountered in the blue clay through which the headings advanced, and on account of this condition a shield was used in driving the center heading on a portion of the approach tunnels. The design of this shield, which was rectangular in shape, having a total height of 16′ 5⅝″ and a total width of 12′ 4⅛″, does not concern us here. Suffice to say that work on the drift with this shield was advanced sufficiently far to permit the excavation of the center wall. The character of the clay, however, required the entire sides and roof of the bore to be heavily timbered. After the center wall had thus been constructed a sufficient distance in advance, the side shield shown in Fig. 6 was used for the remaining excavation.

Four of these shields, built according to the same general



Land Tunnel - Detroit River.

Figure 6.

design, were in operation, one in each of the two headings being advanced on both sides of the river. These shields are slightly more than half cylinders 27′ 1½″ in diameter. The cutting edge is confined to the circular portion and the shield is advanced by twenty-one 8″ hydraulic jacks placed around the cutting edge. Although the course of the shield can be determined to a certain extent by these jacks, it is necessary to guide chiefly from the finished center wall. Under normal conditions the weight of the shield and its load are carried by the lower portion of the curved section of the casing, which has a total width of 13 feet from the cutting edge to the rear of the shield. Two heavy shoes, having their faces vertical, are mounted on the outside of the verticle section of the shield, one near the top and the other close to the bottom, and bear against the rear face of the web of a 12″ steel channel set horizontally in the concrete of the center wall. To provide for emergencies a third shoe with its face horizontal is mounted on a heavy knee brace on the vertical section of the shield in a position directly over the bench on the center wall.

The excavation made in connection with the shield is lined immediately in the rear of the latter with continuous rings consisting of 4-foot segments cut from 12″x12″ maple and beech timbers wedged in place to insure a lining fully capable of carrying the load until the concrete has been placed and received its set. This lining of timber rings is finished with a ring of 2"x2" beech lagging to give a smooth surface for the waterprofing, which consists of three-ply roofing felt laid in hot straight run coal tar pitch. The arch of the tunnel is built in 12-foot sections after the invert and side walls have been constructed. The inverts and side walls are built by the use of removable steel forms made in sections 2 feet wide of 3-16" plates with a 2"x2"x¼" angle riveted along both sides of each three-foot section and horizontally every two feet to stiffen them. The arch forms also consist of steel ribs built up of two angles and a plate with these ribs spaced 3′ 9″ apart on centers and lagged with 3" plank attached to them by wood screws. The arch forms are advanced in 12-foot sections by means of a traveler car.

SUBAQUEOUS TUNNELS: The soft ground tunnel constructed with a side shield shades insensibly into the subaqueous tunnel, and indeed, so far as modern practice indicates, the chief difference between a soft ground tunnel through heavy water bearing strata and a subaqueous tunnel in soft material is the feature of hydrostatic head and the necessity for the employment of compresesd air at high pressure, not as a matter of expediency and to avoid possible difficulties, but as a matter of necessity in view of conditions always present. The hydrostatic pressure increases with the diameter of the tunnel and is always greater at the bottom than it is at the top and its action needs very careful attention in tunnel design and in tunnel driving.

In the construction of subaqueous tunnels the thing chiefly to be desired is to get the roof of the tunnel as high as possible and its depth below mean low water is usually fixed by the harbor regulations which apply in the particular locality where the tunnel is built; as for example, in New York City the harbor regulations require a minimum depth of 40 feet from mean low water to the top of the structure. The higher the roof of the tunnel can be made, the slighter are the grades necessary in approaches and the smaller, as a rule, the expenses of construction, it being sometimes possible to remove a large portion of the material by dredging methods rather than by mining. A smaller depth of water over the tunnel also means a lesser hydrostatic head and consequently a thinner tunnel lining. The danger in having the roof of the tunnel too close to the stream bottom arises from the usual treacherous character of the material, as blowouts may occur during its construction and the tunnel be drowned out entirely. These blowouts may take place through rock fissures or in soft material bodily throughout the entire mass.

The character of the material in the bottom of the stream has, therefore, a large bearing upon methods of subaqueous construction, and subaqueous tunnels may be classified in accordance with the methods which have been taken to overcome unstable conditions into three classes, which are:

1. The Closed Caisson and Excavating Method.
2. The Closed Caisson and Dredging Method.
3. The Shield Method.

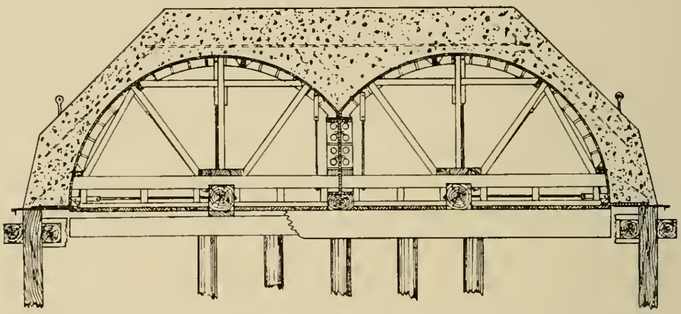
With the first two of these it is not necessary at all that the material in the river bottom should be firm or that the tunnel bed should be below the bottom of the stream more than a sufficient distance to insure a firm foundation. Under the shield method the tunnel must either penetrate firm strata below the river bottom or else an airproof blanket be deposited over its entire extent.

THE CLOSED CAISSON AND EXCAVATING METHOD. The Harlem River Tunnel of the New York Subway System, built in 1903, passes under the Harlem River through mud, silt and sand, the latter flowing with remarkable ease when wet. Between bulkhead lines the river, 26 feet deep, is 400 feet wide, but for 610 feet the tunnel is made of two cast iron cylinders imbedded in concrete. Mr. D. D. McBean, of the sub-contracting firm of McMullen & McBean, devised the following plan for its construction:

He proposed to enclose the space to be occupied by the tunnel by two lines of specially constructed 12" tight sheet piling. Upon these lines of piling cut to the proper level he would lay a timber roof of three layers of 12"x12" timbers separated by courses of 2" plank running at right angles, making the roof 40" thick. Under the protection of the box so made he proposed to excavate the material either with or without the use of compressed air.

In the execution of this plan the river was first dredged so as to leave an average depth of 7 or 8 feet of material to be removed. Four rows of piles were driven 6′ 4″ apart center to center transversely and 8′ 4″ apart longitudinally. They were cut off and capped to support the heavy timber roof and the interior bracing system and eventually were to be cut off at sub-grade to further support the finished tunnel. A line of 12″x12″ sheet piling was then driven along each side of the tunnel in careful alignment guided by a floating wale frame, steel pilot piles being further used to secure accuracy in driving. With the sheeting in place, the 40″ thick timber roof, supported on six lines of 12″x14″ range timbers bolted to their bottoms, was floated into position, and when it was sunk these timbers rested exactly upon the two rows of sheet piling and the four inner rows of round piles. The sunken roof was next overlaid with about 5 feet of earth dredged from the immediate vicinity to bring it to a firm bearing and to provide weight against the uplifting tendency of the air pressure. Each end of the box so formed was closed by suitable bulkheads, making the length of the timber 216 feet, or about half the width of the river, the other half being left open for navigation. When the water was driven from the working chamber formed within the box by compressed air, the leakage was found to be small and the sheeting in excellent alignment. The material inside was excavated with little trouble and the tunnel lined and concreted.

For the building of the second half of the tunnel Mr. McBean was convinced that a more economical form of construction could be devised by the substitution of the upper half of the tunnel itself for the heavy timber roof, especially as the timber roof had no function to perform after the completion of the tunnel. Fig. 7 shows the method by which the second half of the tunnel was constructed. The system of tunnel excavation after this method has been covered by letters patent. As before the site was dredged to nearly sub-grade and a double line of 12″x12″ sheeting driven to form the sides and ends of the submerged box, but the sheeting was now cut off at the springing line of the tunnel to form a footing for the roof, which was built in three sections, two 90 feet long and one 84 feet long, in a floating box 106 feet long, 35 feet wide and 12 feet deep. The bottom of this box was made of 12"x12" transverse timbers laid 4 feet apart and floored with 3"x12" plank. On three 4"x12" longitudinal timbers fastened to the floor of this box was then built a false floor for the upper half of the tunnel made of 16"x16" transverse timbers 8 feet apart carrying a center longitudinal sill of 10"x16" timber and two side sills of 16"x16" timber 6' 3" from the center line. The space between these longitudinals was floored with 2" plank. Upon this false floor the cast iron tunnel was erected in 6-foot rings. Rods and braces were introduced as a precaution against any possible deformation, and suspension bars were built through special cast iron and plate brackets. The roof was then covered with concrete tied together by imbedded reinforcing rods as a further precaution. Each 6-foot ring of the iron shell weighed about 41000 pounds and carried 618 cubic feet of concrete. It was estimated that the total weight of the iron, concrete floor, etc., was about 50 pounds per lineal foot less than the estimated buoyancy of the empty roof chamber. When everything was ready derrick boats were run along the side of the roof, the needle beams, floor, etc., lifted, the submerged box floated out from underneath and the roof lowered into its final position. At convenient intervals in the roof openings had been left for the descent of the workmen and for the removal of material. The excavation went on underneath the roof, which, with the lines of piling, formed a waterproof working space for



Harlem River Tunnel
M^c Bean Method of Construction.
Figure 7.

the workmen. After the excavation had been completed under compressed air the interior of the tunnel was lined with concrete, the end bulkheads, surplus wood, etc., removed, leaving a reinforced concrete tunnel tube. The entire work was completed under the very low air pressure of 10 pounds per square inch.

In this system of tunnel construction any shape desired may be given to the cross section, also any combintion of metal tubes and concrete, either plain or reinforced, can be employed. A twin double track tunnel may be built as readily as a single tube, and such a double track tunnel built as a single tube would possess materially increased rigidity and resistance to vibration under passing trains. This system also permits a much more rapid rate of working than is possible with other methods and provides ample opportunity for any kind of foundation desired underneath the structure.

One of the disadvantages of this method of construction is the excessive weight of the cast iron tunnel segments which have to sustain, in this method of construction, tensile stresses for which they are not perfectly adapted and which require, therefore, an excess weight of material. To obviate these tensile stresses to some degre it is necessary that the false floor be made exceedingly heavy. In addition the design of the section for a double track tunnel is such as to entail a considerable excess of concrete. To obviate these disadvantages and to utilize as well the known advantages of steel in all classes of building construction the design shown in Fig. 8 has been proposed by the Carnegie Steel Company. This design is for the construction of a subway boulevard 60 feet wide having a central column adjacent to which run two street car tracks separated from the roadways by ornamental railing. This tunnel can be constructed after the McBean system by driving wooden side sheeting, or steel sheet piling, building the steel and concrete roof on pontoons and floating into position. Excavation can then be made in perfect safety and convenience under the roof, which is connected by a waterproof metallic seal to the sheet piling. The foundation for the tunnel will be constructed on round timber piles driven with floating equipment at convenient intervals across the tunnel site. The center piles should be longer than the others in order to allow the crown of the tunnel roof to rest upon them during construc-

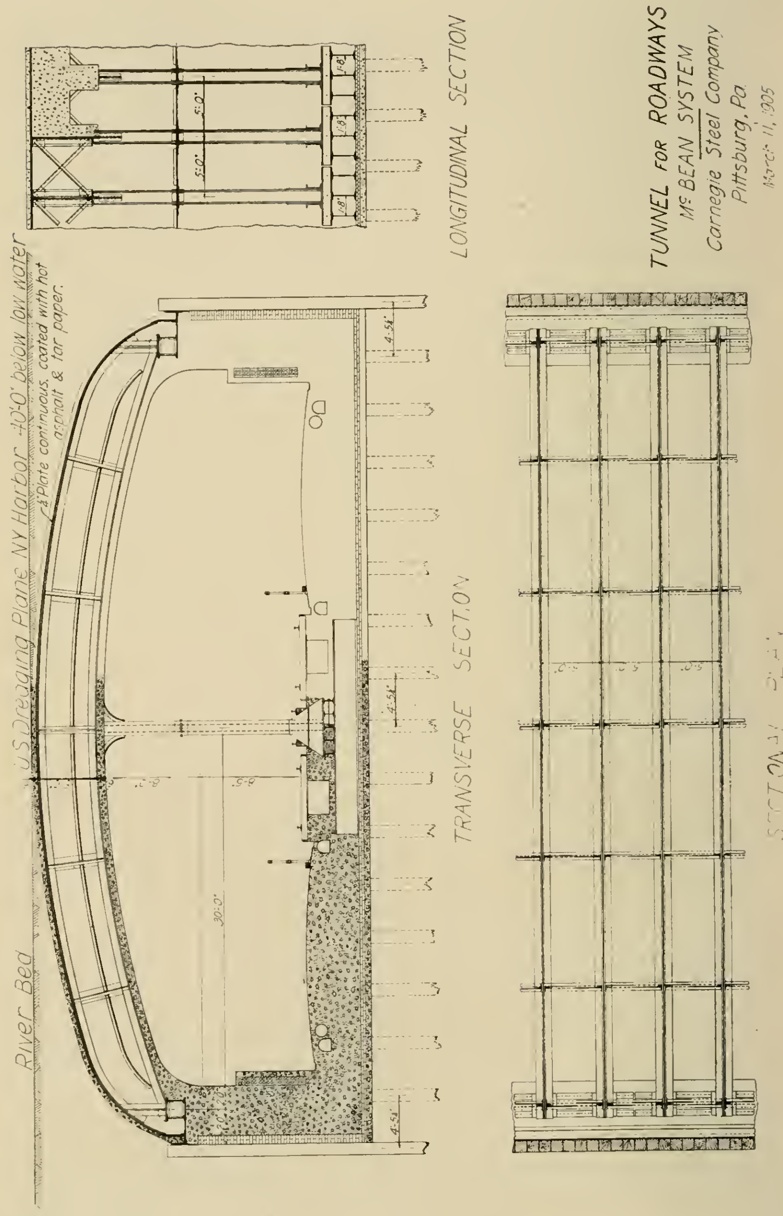

LONGITUDINAL SECTION
5'0"
5'0"
1'8"
1'8"
1'8"
U.S. Dredging Plane NY Harbor 40'0" below low water
¼" Plate continuous, coated with hot asphalt & tar paper.
River Bed
TRANSVERSE SECTION
4'5½"
4'5½"
4'5½"
30'0"
8'5"
8'5"
SECTIONAL PLAN
5'0"
5'0"
5'0"
TUNNEL FOR ROADWAYS
Mc BEAN SYSTEM
Carnegie Steel Company
Pittsburg, Pa.
March 11, 1905

Figure 8.

tion. The steel work is figured for vertical stresses only; horizontal stresses will pass through the concrete and be resisted thereby. Girders would be shipped in two pieces and in erection would be riveted together over the columns and to the 18″ distributing beams at their ends. They will then be assembled in sections and fastened together by chains from one end of one girder to the opposite end of the next so as to prevent separating when lowered into position. These chains are figured for about 88000 pounds thrust in the girder and are to be connected by clevises to 1″ plates between the girders and the distributing beams. This will cause the girders to act as arches during erection. After the sections are lowered into their position and the working chamber opened it will be desirable to excavate the center portion to put in grillage and columns before the side portions are removed. In order to cut down the amount of concrete required it is placed after the manner of floor arches in buildings. The estimated weight of the steel required, including the columns, the girders, the grillage, etc., is 7900 pounds per running foot.

THE CLOSED CAISSON AND DREDGING METHOD. A somewhat

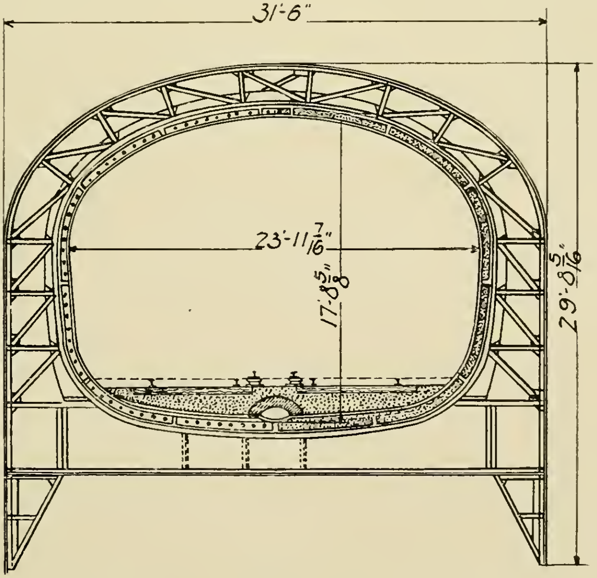
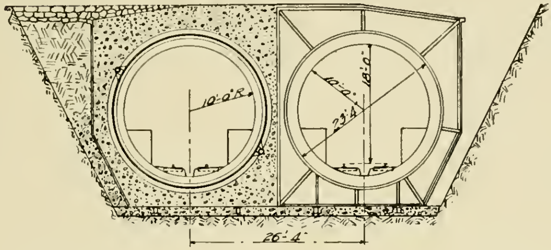


Figure 9.

similar method of construction has been followed in the tunnel crossing under the Seine River by Line No. 4 of the Metropolitan Railway of Paris. The total length of the tunnel is 3584 feet, of which 2038 feet were driven by the shield method, 1320 feet by the submerged caisson and 226 feet by the freezing process. The tunnel is lined with cast iron segments and the same method of lining pertains through the shield driven tunnels, the length built by the freezing process and that built by the caisson method. Three caissons, as shown in Fig. 9, were sunk end to end to form the crossing of the main stream, two others to form the crossing of a smaller branch, while three were sunk to form each of the two stations.

The three river caissons were 118, 126 and 142 feet long respectively and the two caissons for the smaller crossing were each 66 feet long. The caissons were made of structural steel ribs braced together by longitudinal framework consisting of heavy I-beams and short members made of steel angles. The frames were continued below the elevation of the floor to form the working chamber beneath the caisson. The entire framework, including the ends, was covered with steel plates so that when finished the caissons had flat sides and ends and an elliptical top. After erection the caissons were launched and towed into position between pile stagings, which served the double purpose of guiding their descent and forming a working platform. Previous to this sinking the portion of the river bed to be occupied by the caisson had been leveled by dredging. Once in position the cast iron segments were erected within the framework and the annular space between the lining and the shell filled with concrete, gradually sinking the caisson to the river bottom. As the sinking progressed the working shafts were placed in position, air pressure applied and the excavation proceeded with underneath the cutting edge of the caisson. No special difficulty was experienced in sinking the caisson aside from the hardness of the material which had to be broken up by blasting. A space was left between the successive caissons of about 5 feet and it was proposed to close this space by building in a section of lining and steel envelope.

A similar method was followed in the construction of the subaqueous portion of the Detroit River Tunnel, of the Michigan



Section through Tunnel. Section through Tube

SUBAQUEOUS SECTION OF
DETROIT RIVER TUNNEL.

Figure 10.

Central Railroad, 2622½ feet in length. The construction adopted was to build the entire length in ten sections of riveted twin tubes 23′ 4″ in diameter built on shore, floated into position and sunk with the aid of air cylinders to position on a steel grillage with alignment beams laid in a dredged trench with a maximum bottom width of 48 feet and a depth of 32 feet, one such grillage coming at each joint. The arrangement of the completed tube and the steel frame is shown in Fig. 10. The steel tubes were made of ⅜″ plates with caulked lapped joints having double rows of ¾″ rivets. The exterior of each tube was reinforced with transverse vertical diaphragms 12 feet apart made with ⅜″ plates reinforced by pairs of 3½″x3½″ angles on the outer edges. The shape of the plate conformed to the cross section of the concrete jacket, the lower edge being horizontal to serve as a cradle supporting the tubes on the steel grillage in the trench. Intermediate between the diaphragms were inside 3″x3″ flange angles with connections for twelve 1″ adjustable radial rods connected to a center ring to provide interior bracing and to prevent deformation in handling. Before launching each end of each tube was temporarily closed with a timber bulkhead taking bearing against 3½″x3½″ inner flange angles of the tube. A pair of tubes 262½ feet long altogether, weighing about 550 tons, were launched transversely and floated into position between rows of guide piles about 30 feet each side of the center line of the tunnel. Each tube was equipped with two horizontal steel air cylinders about 10 feet in diameter and 60 feet long temporarily secured with adjustable chains to cradles in the diaphragms, as indicated in the general elevation.

The upper end of the trench in which the steel tubes lie was excavated by a dipper dredge and the lower part by a clam shell dredge provided with a specially designed clam shell bucket. The bottom was approximately leveled and the steel grillages sunk into approximately accurate position to receive the steel tubes. After the tubes had been centered over the grillages they were sunk into position by opening inlet valves in the lower part of the bulkheads and outlet valves in the upper parts; water enters through the former causing the tubes to sink slowly. Enough water was admitted to sink the tubes below the surface until the air cylinders on top commenced to be submerged, maintaining the tubes in a horizontal position and preventing them from sinking further until their buoyancy was overcome. They were thus maintained in an even balance and gradually lowered to the bottom under perfect control without danger of severe stresses or distortion. After the sections were sunk and adjusted to exact position concrete was filled beneath and around the tubes, forming a monolith concrete structure in which are two steel lined tubes 23′ 4″ inside diameter. This concrete is deposited under water through steel tremies in an outside form with vertical walls, between which and the sides of the dredged trench the space was backfilled. After the outside concreting was in place the tubes were lined with concrete 20″ in thickness.

The underlying principles of the construction are as follows:

The steel shell serves first as a form for confining the outside concrete deposited through the water and later forms a perfect waterproofing for the completed tunnel. The outside concrete is of sufficient dimensions and strength to resist hydrostatic pressure when the water inside the steel tubes is pumped out in order to enable workmen to go inside and construct the tunnel proper without the employment of compressed air. The outside concrete fills up all depressions and irregularities in the bottom of the tunnel trench and makes, so to speak, its own bed. This will eliminate any tendency to settlement after the tunnel is completed and in use, and if the bottom has a tendency to yield or settle, it will do so while the outer concrete is being deposited rather than after the tunnel is completed. The tunnel proper, which is built inside of the steel shell and the outer concrete casing, is of sufficient strength to resist all loads, whether hydrostatic, static or live, which may come upon it. It can be built in long sections at a time and under a strict and reliable system of inspection.

THE SHIELD METHOD. The construction of subaqueous tunnels of large extent through soft materials under the beds of streams without removal of the cover has been made possible by the shield method in connection with the use of compressed air and metallic tunnel lining. It has succeeded where attempts to tunnel by ordinary mining methods with or without compressed air and with the use of brick lining have failed. Consequently it may be looked upon as the most perfect method of subaqueous tunnel construction.

HISTORY. The shield method of driving subaqueous tunnels was invented by Mark Isambard. Brunel. This remarkable engineer, born in Brittany, educated for the ministry, trained alike in seamanship, surveying, architecture, timber production and manufacture, inventor of shoemaking machinery, improved copying pens, methods of polishing tin foil, etc., etc., applied to the construction of the Thames River Tunnel the best of his skill and experience, and did what the best engineers of his day could not do. The tunnel was first proposed in 1798 by Ralph Dodd, but abandoned. In 1804 under act of Parliament a tunnel from Rotherhithe to Limehouse was begun when a shaft 11 feet in diameter was sunk 42 feet with a view to the commencement of the horizontal excavation. Work was soon suspended, to be resumed with a diameter of 8 feet in 1807 by the Cornish engineer, Trevithick, and a small heading carried 923 feet, or to within 150 feet of tthe opposite shore. Trevithick then made an opening in the top of the heading to test the alignment with the result that he and his party were almost drowned, the heading was filled up and the work abandoned. After various plans had been proposed for the construction of the tunnel it was taken up in 1824 by Brunel, who sunk a new shaft of brick work 50 feet in diameter, 42 feet high and 3 feet thick, built on a metal cutting edge bodily into the ground by what are now called caisson methods. From this shaft he proceeded with the tunnel, which, when completed, was a brick structure 38 feet by 22′ 6″ enclosing two horseshoe shaped tubes 16′ 4″ high by 13′ 9″ wide separted by a 3′ 6″ brick wall, pierced occasionally with openings. The shield was placed in position by January 1, 1826. It consisted of 12 great frames 22 feet high and 3 feet wide, made of cast iron with a cutting edge top and bottom and divided into three stories, thus presenting 36 cells or working platforms both front and back for the workmen, namely the miners, by whom the ground was cut down in front and the bricklayers, who simultaneously with the advance of the shield placed the brickwork of the finished structure. The leaves of the shield were advanced by powerful screw jacks, and the vertical face was protected by horizontal poling boards which could be handled separately and pushed forward as the ground was excavated. The water broke in several times, impeding the work, to be stopped by bags of clay dumped into the chasm; financial conditions also interfered to delay the completion until 1843, but the shield was a success from the start. It embodied all the fundamentals of the modern type except the tail tube, which came in use with tunnels of circular form.

The annular shield and cast iron lining were first used by James Henry Greathead. Greathead was born in Grahamstown, Cape Colony, on August 6, 1844, came to England in 1859 and in 1864 became a pupil of P. W. Barlow, through whom he became acquainted with the shield method of tunneling. Barlow had a strong belief in the shield and was the author of a scheme to facilitate London traffic by the construction of underground railroads running in cast iron tubes built with its aid. To show what the method could do it was resolved to make a subway under the Thames near the Tower, but the trouble encountered by Brunel in the Thames Tunnel made engineers hesitate to undertake the subway, though it was of much smaller dimensions—6′ 7″ in diameter (some say 8′ 0″). At this juncture Greathead offered to take the contract and he successfully carried it through without resort to the use of compressed air, which Barlow in 1867 suggested might be employed in water bearing strata. In 1884

Parliament authorized the construction of the City and South London Railway, to be worked by the Hallidie system of cable traction. This was begun in 1888 and the tunnel was driven by means of the Greathead shield, compressed air being used in water bearing strata when necessary. During the progress of the work electric traction became so far developed as to be superior to cables and when the line was opened it was an electric one. The railroad is 3 1-6 miles long entirely underground and consists of two 10′ 6″ cast iron lined tunnels substantially parallel to each other, which converge into a single tunnel at the terminal.

Where Barlow got the idea of lining tunnels with cast iron does not appear. It is significant that coal mine shafts have been lined with cast iron tubbing rings for more than 50 years, and it is more than likely that their use in tunnels is the application to horizontal passages of a method of construction long approved by English and European practice in sinking deep shafts through soft and water bearing strata under difficult conditions, and is but another proof of our preposition that tunneling is essentially a mining operation.

Compressed air was first used in the United States in 1880 by D. C. Haskin in the Hudson River Tunnel, where an attempt was made to drive a double track tunnel through the mud and silt with a pilot tube 6′ 6″ in diameter advanced 30 to 40 feet ahead of the main tunnel, to form a firm support for the iron plates of the latter by means of radial screws. Compressed air at a pressure of 20 pounds per square inch prevented the weight of silt and water from crushing the plating and flowing into the tunnel.

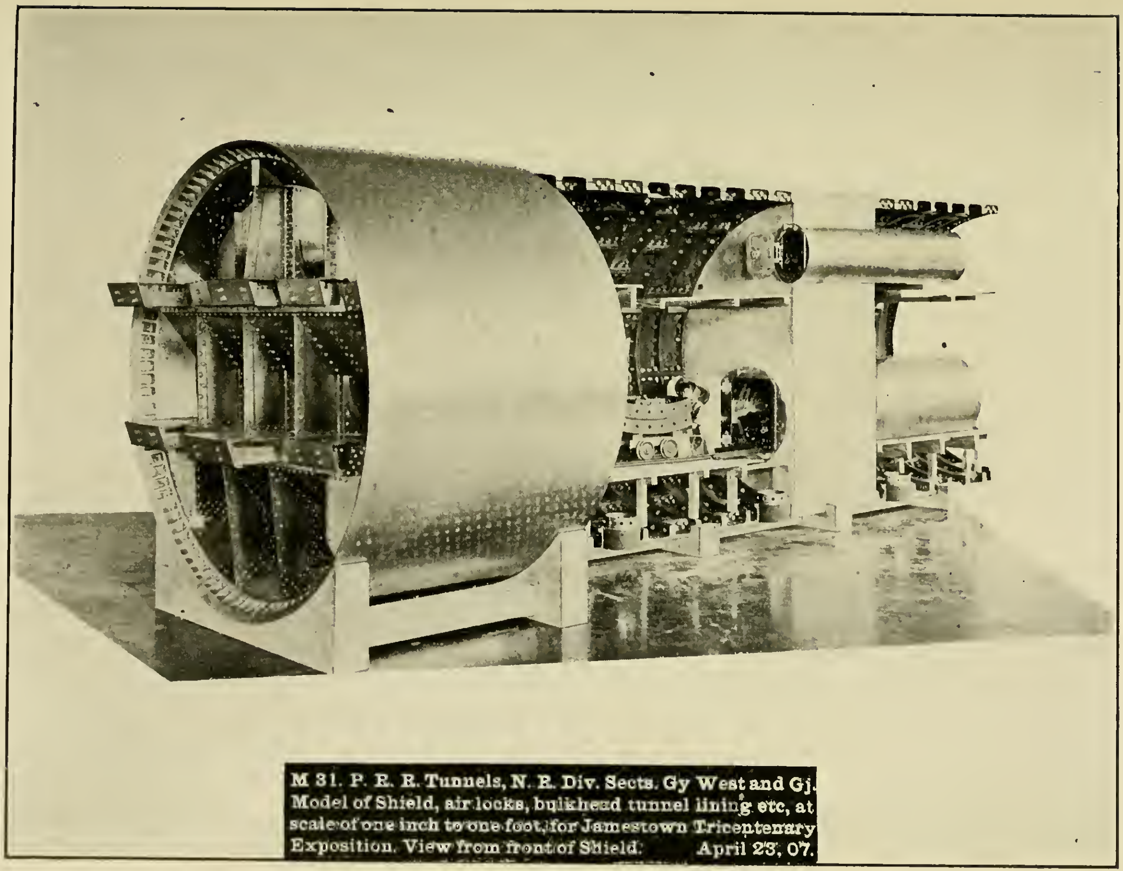
Where open gravel or running sand heavily charged with water are met a diaphragm must be fitted to the shield. Mallet proposed in 1858 to carry in this way a tunnel under the English Channel. The pneumatic shield designed by Sir Benjamin Baker is the outcome of this idea. His shield is supported against external pressure by girders 6 feet apart. Horizontal shelves of steel plates with cutting edges are spaced about 4 feet apart, and the face of the shield is closed by vertical plates, slides and doors, so as to admit the materials being excavated, while the compresesd air prevents the influx of water. Where firm clay is met the shield plates may be unbolted. When sufficient material has been excavated the shield is advanced by hydraulic pressure and the lining built under the tail of the shield. The Blackwall Tunnel, 3116 feet long and 24′ 3″ inside diameter, built in 1892 to 1897, was built with a shield 28′ 8″ outside diameter, 19′ 6″ long, with bulkheads, movable shutters and other important features embodied in Mr. Baker's design. The shield was pushed ahead by twenty-eight 100-ton hydraulic jacks abutting against the cast iron lining, which was placed in position by two hydraulic erectors. This type of shield is that used on the Pennsylvania Railroad Tunnels into New York City.

Various plans have been suggested for the removal of the material in front of the shield. Mr. Greathead would effect it by a closed current of water carrying the stuff through the shield from front to back. In part of the Hudson Tunnel work the shields were driven through mud and silt, plowing it aside.

The first American subaqueous tunnel constructed and completed by the shield method was the St. Clair under the St. Clair River at Sarnia, built inside a cast iron lining, under Joseph Hobson, Chief Engineer, Grand Trunk Railroad. The shields were 21′ 6″ in diameter and 15′ 6″ long, made of 1″ steel plates stiffened by five diaphragms dividing it into 12 cells. There were 24 hydraulic jacks, each capable of 125 tons pressure, but the total power used did not exceed 1800 tons. Each lining ring is 18″ long, made up of 13 segments and a key. Each segment weighs 1050 pounds and the total weight of the cast iron lining is 27000 tons.

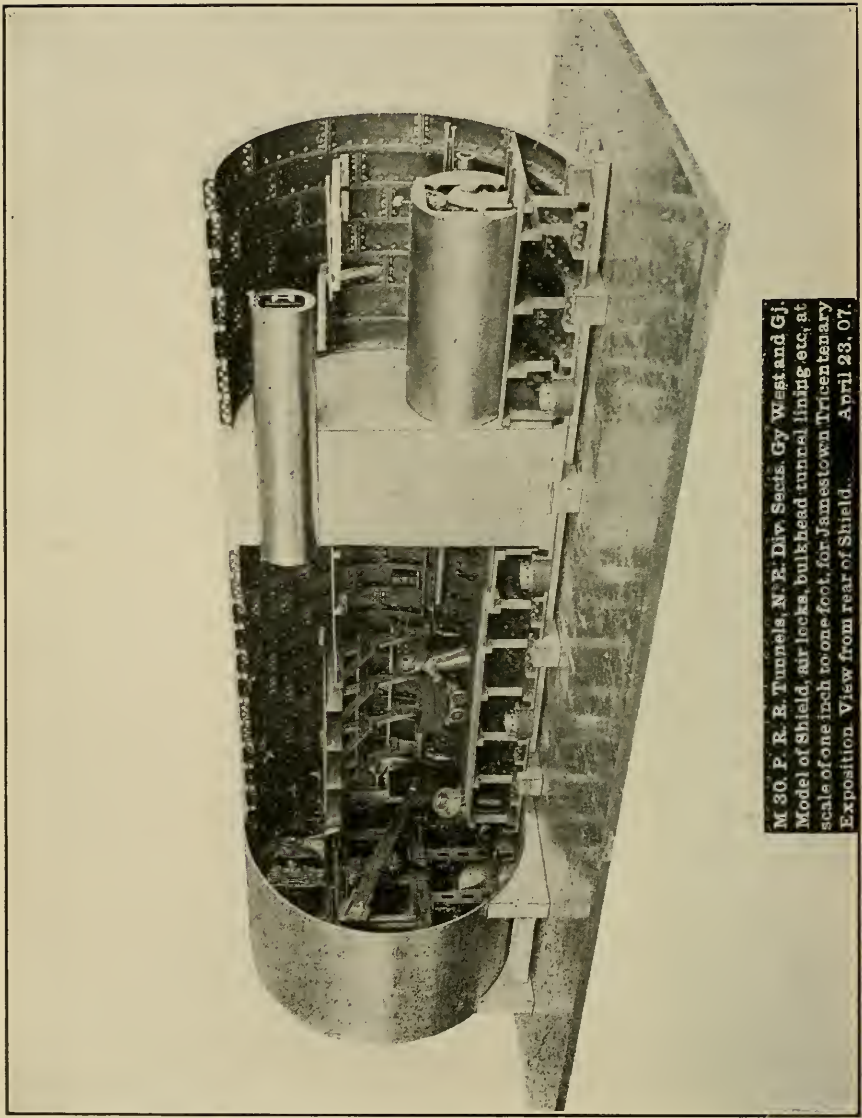
Parts of the Shield. It will be noted from the discussion that the construction of the shield varies somewhat in accordance with the character of the work under construction. The Brunel shield was rectangular in form to conform to the outline of his tunnel section. Modern subaqueous tunnels are usually circular in order to get the benefit of the full strength of the circular form of section. This explains to some degree why the circular form is better adapted also to the shield.

The system of tunnels under the North and East Rivers, by which the Pennsylvania Railroad gains access to New York



M 31. P. R. R. Tunnels, N. R. Div. Sects. Gy West and Gj.
Model of Shield, air locks, bulkhead tunnel lining etc, at scale of one inch to one foot, for Jamestown Tricentenary Exposition. View from front of Shield. April 23, 07.

Figure 11.



M 30. P. R. R. Tunnels, N. R. Div. Sects. Gy West and Gj. Model of Shield, air locks, bulkhead tunnel lining etc, at scale of one inch to one foot, for Jamestown Tricentenary Exposition. View from rear of Shield. April 23, 07.

Figure 12.

City and Long Island, is the greatest piece of subaqueous tunnel construction ever attempted. The length of the work and different conditions naturally to be expected required careful consideration in the design of the tunnel shields, air chambers, etc. The contractors for the North River Tunnels were the O'Rourke Engineering Constructing Company, and for the East River Tunnels S. Pearson & Sons, Inc. The latter contractors had built the Blackwall Tunnel in London by the use of a shield patterned after the design of Sir Benjamin Baker's. The Chief Engineer on the North River Tunnels was Mr. Charles M. Jacobs, who had been Chief Engineer of the old Hudson River Tunnel and also of the other tunnels projected and built under the Hudson River. The forms of the shields used in the North River Tunnels, therefore, varied somewhat from those used by Pearson in the East River Tunnels. The essential features, however. were, of course, the same. The Figs. 11 and 12 show the front and back of the shield used on the North River Tunnels. The external diameter of the shield was 23′ 6¼″; its length 15′ 2⅜″. The skin of the shield was made up of three steel plates ¾″, ⅝″ and ¾″ respectively, making a total thickness of 2⅛″, thus leaving an inch space all around between the tail of the shield and the tunnel lining. The tail of the shield overlapped the lining a maximum of 6′ 4½″ during ordinary working and a minimum of 2 feet during the operation of taking out any rams for repairs. This overlap also permitted the removal of any segment which might be fractured during the process of shoving the shield against it without exposing the dangerous ground.

The essential parts common to all large shields operating under compressed air are as follows:

1. The Cutting Edge—Usually made of cast steel riveted to the shield skin and braced against the first diaphragm by structural steel brackets.

2. The Working Platforms:—Extending out under the cutting edge for use of workmen in excavating, forepoling, etc. These platforms are usually fixed. In the North River Tunnel shield there were eight of these platforms which could be extended 2′ 9″ in front of the shield by means of hydraulic rams, independent of the shoving rams, and when extended were strong

enough to carry a load of 7900 pounds per square foot, this being equivalent to the maximum combined head of muck and water. These sliding platforms were conceived by Mr. James Forgie in 1894 and first adopted in 1895 under the direction of Mr. Greathead on the shield of the 23-foot internal diameter tunnel of the Waterloo and City Railway, London. They were used in America in 1903 in the shield of the South Tunnel of the Hudson & Manhattan Railroad Company.

3. THE HYDRAULIC RAMS. The rams of the North River Tunnel shield were 24 in number with a net diameter of 8½" and a stroke of 38", and were designed for a minimum pressure of 2000 pounds per square inch, a maximum pressure of 5000 pounds and a test pressure of 6000 pounds. The average working pressure was 3500 pounds per square inch. The forward pressure of one ram under a maximum pressure of 5000 pounds per square inch was 275000 pounds; total pressure 3300 tons. The rams were made subject to individual control so that differential pressure might be applied around the shield under the varied conditions encountered, the worst situation probably being the case of a tunnel half in rock and half in soft material. In the East River Tunnel shields there were 27 rams, 9" diameter, 3 feet stroke, tested to 9000 pounds per square inch.

4. THE DIAPHRAMS AND BULKHEADS. The North River shield had only one transverse bulkhead; no air locks or other provisions for maintaining higher face pressure and no material shoots or any discharges other than the nine openings fitted with doors. The East River shields were divided into nine pockets by two vertical diaphragms and two horizontal floors, and in addition to the two vertical diaphragms there were two transverse bulkheads completely closing the shield except for openings made for doors and muck shoots. The object of these two bulkheads was to maintain differential air pressure. By closing the doors of the forward bulkhead air could be pumped into the shield at a higher pressure than the pressure in the tunnel. The two transverse bulkheads also gave the shield an added stiffness. Great difficulty with this feature would have occurred in material composed part of rock and part of quicksand and the small reservoir of air contained in the shield would have caused great variation of pressure in the event of blows and flooding would have been

frequent. As the maximum pressure in the East River Tunnels was only 37 pounds per square inch, this refinement of diaphragms and bulkheads proved unnecessary and some of the material was cut out in order to permit more speedy operations.

5. THE TAIL. The Brunel shield had floors in front for the use of the miners and at the back for the use of the bricklayers, and the brick lining was placed as the shield advanced. It is apparent that there is always a possibility of the flowing of material and the dripping of water into the tunnel through the space between the end of the shield and the lining. The tail in the modern shield avoids this difficulty by at all times extending over two or three lining rings, which are erected within the tail itself. The space between the lining and the shield being only 1″, very little chance of material entering therein is afforded, and this is to be looked upon as one of the elements of large importance in subaqueous tunnel construction and an evidence of the farsightedness of Sir Benjamin Baker.

6. THE ERECTOR. The weight of one ring of tunnel lining in the North River Tunnel was 23737 pounds, or an average of more than a ton per segment. They were, therefore, erected, as is common in modern tunnel practice, by means of an erector mounted on the shield itself and consisting of a box shaped frame mounted on a central shaft, which revolved in bearings attached to the shield. Inside of this frame was a differential hydraulic plunger 4″ and 3″ diameter and 48″ stroke. To the plunger head were attached two channels which slide inside the box frame and to the projecting ends of which was attached the grip. At the opposite end was a counterweight which balanced part of the weight of the tunnel segment. The erector in the North River Tunnel was revolved by two single acting rams fixed horizontally to the back of the shield, and with the single erector six rings of tunnel lining have been put in in eight hours. The East River Tunnel differed from the North River Tunnel in having two erectors moving about an angle of 236 degrees each. The erector in the North River Tunnel was operated under 1000 pounds per square inch pressure.

The total weight of the North River Tunnel shield was fully 200 tons; of the East River Tunnel shield 185 tons.

Rate of Progress. The rates of progress in subaqueous tunnel practice vary, of course, with conditions. The record for the United States seems to have been made in the construction of the South Tunnel of the Hudson & Manhattan Railroad Company, where large use was made of the method of advancing by closing the shield doors and shoving ahead in the soft silt and mud without excavation, as much as 62 feet being done in 24 hours and 348 feet in a single week. The entire length of the South Tunnel was 5100 feet. It was excavated in 334 actual working days at an average rate of 15.3 lineal feet per day. The four Long Island shields in the East River Tunnels, Pennsylvania Railroad Company, excavated 4195 lineal feet in 120 days, at an average rate of 8.74 feet per day for a shield.

The most serious difficulty encountered in the shield method of construction comes from falls of sand from the face and from blowing out of the cover. The most effectual method to prevent these blowouts is that discovered years ago by Brunel of dumping clay into the chasms caused by the inrush of material and water, though something can be done by heating soft material in advance of the shield to dry it out and make it more stable.

There are three methods of excavation usually employed in advance of the tunnel. The ordinary method in comparatively firm ground of forepoling ahead and of excavating from the platforms; the pushing aside of the material bodily by closing the doors in the tunnel shield and forcing ahead with hydraulic jacks; also that of sluicing the material through the shield mixed with the proper proportion of water. A fourth method was followed in the Rotherhithe Tunnel under the Thames, which was opened to traffic on June 12, 1908. It was built in a little over four years, though the contract allowed 5½ years for its construction. The tunnel, 30 feet in diameter, was driven by the use of two shields advanced from opposite ends of the tunnel. One of these was 5 feet shorter than the other, as it had to work around a long curve of 800 feet radius. The longer shield was built of cast steel segments 60 in number in three rings, the segment in each ring breaking joints with those in the next, and weighed 380 tons. The front portion of the shield was provided with 16 working compartments by three vertical and three horizontal partitions, and the tail of the shield, 7′ 3″ long, was built up of three thicknesses of ¾″ plates riveted together. The shield was advanced by 40 rams 9″ in diameter with 3′ 6″ stroke, fitted with small internal drawback rams. These rams exerted a pressure of 3 tons per square inch, or about 6000 tons in all, and the lining was erected by two hydraulic erectors consisting of the usual arrangement of sluing rack, pinion and sliding arm.

From borings on both banks it was thought probable that a bed of clay extended across the river, and in order to obtain definite information a small pilot tunnel was driven across the river in advance of the main heading. This pilot tunnel was 12′ 6″ in diameter, lined with cast iron, the top being 2 feet below the top of the main tunnel. It was driven with a shield fitted with a rotary excavator of the pattern introduced by the contractors in the construction of several of the London tube railways and in general resemblance to a rotary snow plow. The cutters were of steel and when the cutter head revolved scored concentric curves in the material forming the face. The speaker has called attention several times to the resemblance between shaft sinking by approved modern European methods and subaqueous tunnel driving, and would respectfully suggest that this method of a rotary cutter might be further extended and that a large size subaqueous tunnel might be constructed with the boring machines used in sinking deep shafts through water bearing strata.

Lining. Since the days when Greathead built the Tower Tunnel practically all subaqueous railroad and passenger tunnels have been lined with cast iron. The Thames Tunnel, built by Brunel, was lined with brick in cement by bricklayers who placed them directly from the platforms of the tunnel shield. The bricks were thus laid as the shield advanced, nevertheless there was always an unprotected space between the brick lining and the shield through which water and silt might pass into the tunnel. The Severn Tunnel and the Mersey Tunnels, built in 1873 to 1886, were also lined with brick laid in cement, but these two were rock tunnels—subfluvial but not subaqueous.

Apart from its longitudinal weakness one great disadvantage in brick lining is the necessity for centers on which to construct the arches. These can be made movable, but only serve to crowd space already well filled and in so far to interfere with the progress of the work. In some cases, however, brick lining is most desirable and water works and drainage tunnels are properly lined that way, whether driven with shield or without. The Flushing Tunnel for the Gowanus Canal in Brooklyn, for example, is so lined. This tunnel, 6270 feet long, is circular with an inside diameter of 12 feet and is lined with four rings of brick laid in cement, making a wall 16″ thick at all points. The tunnel was driven from two headings by the shield method under compressed air at 7 pounds pressure. Each shield was 15 feet long and 14′ 8½″ in diameter and weighed, with its jacks, etc., about 55 tons. The length of the shield was somewhat more than is common in tunnels of approximately the same diameter and the rear end projected 5′ 10¾″ behind the back diaphragm to form a tail piece, inside which the brickwork was built. The shield was equipped with fourteen 140-ton Watson-Stillman jacks with automatic drawbacks. These jacks had 8½″ pistons, 36″ stroke and reacted against a heavy cast iron ring which covered the entire face of the brickwork and distributed the pressure over it. This ring was attached to the rams of four of the jacks and when the rams were drawn back after making a shove, they carried the ring with them. The centering ribs consisted of four segments of two 4″x3″ angles riveted together so that each angle projected a foot beyond the other on opposite ends to allow for joining the segments together. The ribs were circular and both ribs and lagging went all the way around. The bricklayers laid the lagging up to the spring line as fast as they laid the brick, and this protects the green brickwork from damage due to walking upon it. The usual time for two bricklayers to complete a 34″ ring of brickwork was 4½ hours, so the progress of the tunnel was limited to the rate of setting the brickwork. The average progress of each shield was 11 feet in 24 hours.

Fig. 13 shows the cross section of tunnel and detail of cast iron lining of the Pennsylvania Railroad's New York Tunnels. This lining is of the usual tube type as developed in the light of experience and may be comsidered as the embodiment of modern tunnel practice. In addition to the standard cast iron lining, cast steel rings of the same dimensions were provided for use in a

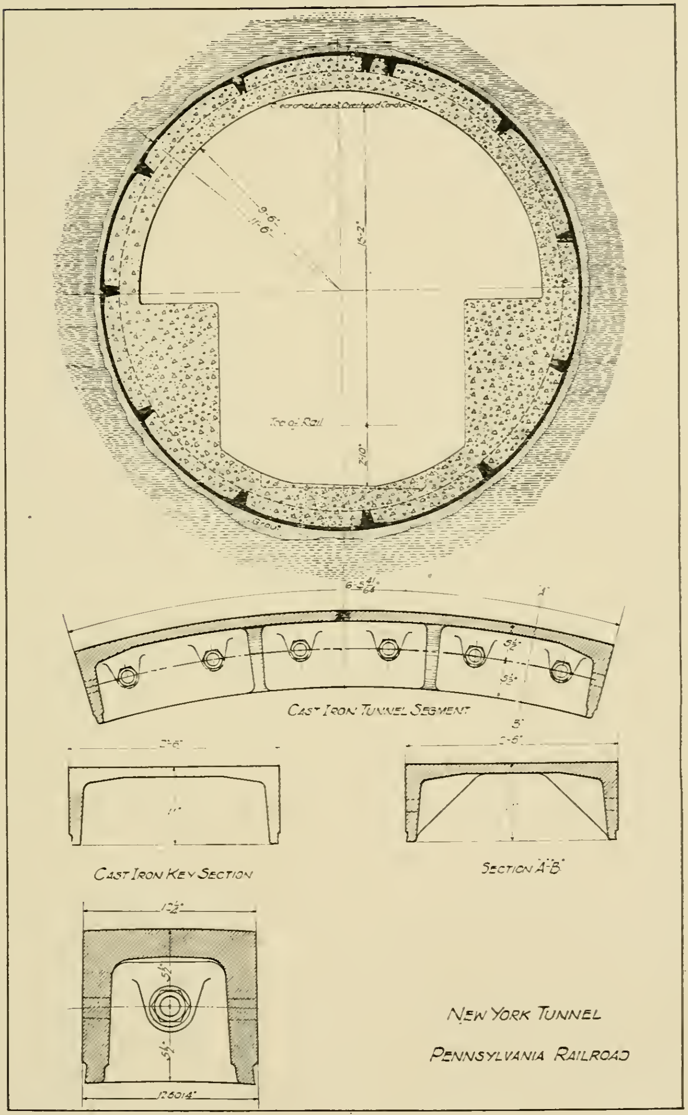

Clearance Line of Overhead Conductor
9'-6"
11'-6"
15'-2"
Top of Rail
7'-10"
Grout
6'-5 41/64"
A
5½"
5½"
B
Cast Iron Tunnel Segment
2'-6"
1"
Cast Iron Key Section
2'-6"
Section A-B
12½"
5½"
5½"
12.6014"
New York Tunnel
Pennsylvania Railroad

Figure 13.

short stretch of the tunnel when passing from rock to a soft ground foundation, where it was anticipated that unequal settlement and consequent distortion and increase in stress might occur. The rings were 30″ wide and composed of 11 segments and a key. Each segment weighed approximately 2020 pounds and the key 520, the total weight being 9102 pounds per lineal foot of tunnel. Each segment is stiffened to resist the back pressure of the jacks by two ribs on each side. These ribs do not come into any fixed relation to the rams, but the ram pressure is applied through the heads over at least one rib at any possible position.

Just as in coal mining operations the size of mine timbers is fixed by judgment and experience, so the thickness and form of the cast iron segments seem likewise in the ultimate analysis to be based on experience rather than on mathematical calculation. The lengths of the rings in the Tower Subway was 18″, in the St. Clair Tunnel 18¼″, in the City and South London Railway Tunnel, 18″, 19″ and 20″, in the Hudson Tunnels of the Hudson & Manhattan Railroad 20″ and 24″; in the Blackwall Tunnel the length was increased to 30″ and the same dimension has been followed by the Pennsylvania Railroad. The length is a matter of convenience. The longer length means a greater shove of the shield, less time spent in moving equipment and consequently greater economy in construction. The longer length, however, means increased weight of segments, greater thickness for the same strength and heavier erecting equipment. It has been said the thickness is a matter of experience. This is borne out by the history of the Hudson River Tunnels of the Hudson & Manhattan Railroad. The cast iron lining at the start had an inside diameter of 18′ 2″ and an outside diameter of 19′ 6″; each ring was 20″ wide, composed of 9 segments and a key. The segments were 1¼″ thick in the web, with flanges 8″ deep and 1½″ thick, and the joints were not planed. On account of the appearance of serious weakness a new and heavier lining was substituted after 286 rings were in place. In the new type all joints had planed faces, the ring was composed of 11 segments and a key and the thickness was increased to 1½″ with 9″ depth of flange. 380 rings of this type were placed when the design was again changed; the depth of flanges was reduced to 8″ again, the web remained 1½″ thick, but the flange thickness was increased to 2¼″.

One of the recommendations of the cast iron segment has been the cheapness of the material of which it is made. This cheapness is offset in modern practice by the machine work on all four sides necessary to provide the fineness of workmanship demanded by considerations of watertightness, and endeavors have been made to devise some means to avoid it. As noted, in the first Hudson Tunnel work the joints were not faced and this probably constituted one element of structural weakness. Henry Japp, Managing Engineer of S. Pearson & Son, Inc., has covered by letters patent a pressed steel tunnel segment of large merit. Pressed steel equipment has not yet, however, reached the development necessary for the production of so accurate workmanship, and the equipment suitable for this work would of necessity be heavy and expensive. Moreover the segments would either need to be short, which would mean more time in erection, or if the same length as the cast iron, would need to be stiffened by angle iron stiffeners to resist the ram pressure.

Structural shapes and plates, however, are the logical successors of cast iron in building construction and it is confidently believed that a steel segment can be designed economically to replace the cast iron. This confidence is based on the fact that steel is a material of universal application in building construction, that it possesses strength and stiffness and has been employed in lining mine shafts in place of cast iron tubbing and, therefore, in vertical tunnel construction if not in horizontal. Such a design is shown in Fig. 14 and its basis is worth some attention. The tunnel lining is subject to stresses in three general directions—transversely as a tube to resist the weight of superincumbent material under hydrostatic head, longitudinally as a beam under bending moments due to inequalities in the excavation, differences in material, etc., and longitudinally also as a column to resist compressive stresses due to the back pressure of the rams.

Considered as a thin walled tube subject to a uniformly distributed internal pressure which would tend to split it longitudinally, such as would be produced by a weight of superincumbent

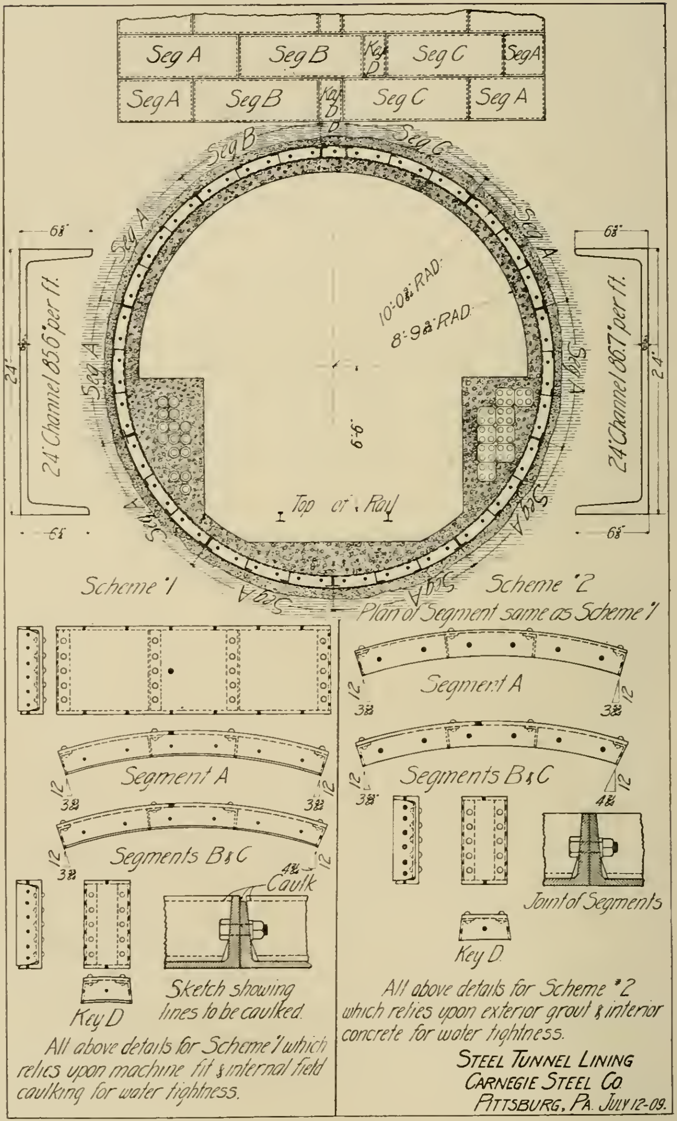

Seg A
Seg B
Key D
Seg C
Seg A
Seg A
Seg B
Key D
Seg C
Seg A
D
Seg B
Seg C
Seg A
Seg A
Seg A
Seg A
Seg A
Seg A
Seg A
Seg A
6⅜"
24"
24" Channel 85.6# per ft.
6⅜"
6⅜"
24"
24" Channel 86.7# per ft.
6⅜"
10'-0⅜" RAD.
8'-9⅜" RAD.
6'-6"
Top of Rail
Scheme 1
Scheme 2
Plan of Segment same as Scheme 1
Segment A
12
3⅜
12
3⅜
Segments B & C
12
3⅜
12
3⅜
4¾
Caulk
Key D
Sketch showing lines to be caulked.
All above details for Scheme 1 which relies upon machine fit & internal field caulking for water tightness.
Segment A
12
3⅜
3⅜
12
Segments B & C
12
3⅜
4¾
12
Joint of Segments
Key D
All above details for Scheme 2 which relies upon exterior grout & interior concrete for water tightness.
STEEL TUNNEL LINING
CARNEGIE STEEL CO.
PITTSBURG, PA. JULY 12-09.

Figure 14.

material under hydrostatic pressure, the thickness of lining required for a tunnel 20 feet in diameter under 100 feet hydrostatic head would be, on the usual assumptions as to ultimate tensile strength with a factor of safety of 4, 1.056″ for cast iron, .44″ for wrought iron and .33″ for medium steel; with a factor of safety of 8, 2.112″ for cast iron, .88″ for wrought iron and .66″ for medium steel.

The longitudinal stresses due to inequalities in settlement are in the nature of the case indeterminate, but are beyond question small in comparison with those due to the hydrostatic pressure applied transversely. They are resisted by the bolts connecting the tunnel rings and it appears reasonable that if the number of bolts fixed by experience in the cast iron lining is ample, it will not be necessary to use more in the steel. Moreover in the steel the stiffeners extend clear across the segment and lend to the ring their tensile strength and stiffness, while in the cast iron lining the ribs are not continuous and there is no strengthening or stiffening of the central portion of the segment.

The buckling of the sections under ram pressure may be prevented either by thickness of metal in the webs of the sections or by the use of stiffeners, it being understood that the packing plates which are placed under the rams will be of sufficient area to produce a uniform distribution of pressure over the web or stiffener. With the web secured against buckling the resistance up to the elastic limit would be equal to the fibre stress multiplied by the web area. The ultimate shear value of medium steel may be taken at 48000 pounds per square inch, elastic limit 50% to 60% of the ultimate. On the basis of 50% the resistance of a 24″ channel would be 288000 pounds if ½″ thick, 360000 if ⅝″, 432000 if ¾″. If stiffeners be omitted the safe resistance of the web at 24000 pounds against buckling will be 160400 pounds if ½″ thick, 241400 if ⅝″, 322200 if ¾″. Inasmuch as the maximum forward pressure of one ram in the Pennsylvania Railroad Tunnels was 275000 pounds, it will be seen that if stiffeners are so arranged that one stiffener at least comes under each ram, ½″ web thickness will be sufficient, and if no stiffeners are used, the steel need be but 11-16″ thick; and that, therefore, a 24″ channel with a ⅝″ web stiffened by heavy angles will be ample construction under ordinary conditions. The same conclusion is reached from the fact that the cast iron lining 1½" thick has proven satisfactory in a number of tunnels and it, on the same basis of calculation, is only good for 296600 pounds. The elastic limit loads are used in this calculation as against the maximum ram pressure; the working pressures and the unit stresses, therefore, are much less. The use of stiffeners also strengthens the steel segment in the center, where the cast iron is weak.

Watertightness. Outside the mechanical fit of the cast iron segments watertightness is effected by methods of grouting and caulking. A certain proportion of the segments are tapped with 1½" holes closed with screw plugs. Through these grout is forced under pressure to fill the space between the lining and the excavation. Care has to be taken in grouting to prevent contact with the tunnel shield, as the filling of the space between the lining and the shield will cause the latter to freeze fast or else impede its movements; grout behind the tail of the shield may also impede progress by increasing the friction. In the East River Tunnel, Pennsylvania Railroad, a modified quick setting natural cement manufactured expressly for this work gave the best satisfaction. Grouting behind the lining is necessary only in firm material or rock; in silt or fine sand the small cracks are soon filled with the silt or sand and further passage of water prevented. The clay blanket has the same effect when in contact with the lining.

Most cast iron tunnel linings are made with a caulking space usually machined on their outer faces. Where two rings or segments bolt together these spaces form a continuous groove, which are filled with caulking material driven home with a tool. The rust joint mixture of iron filings and sal-ammoniac, in the proportions of 400 to 1 by weight, is in common use for this purpose. The plan approved for the first Hudson River Tunnel called for the placing of strips of creosoted wood between the longitudinal flanges of the segments. In the East River Tunnels of the New York Rapid Transit Railway, 16′ 8½" in diameter with 22" cast iron lining rings, the joints were caulked by driving a lead strip tightly into the bottom of the groove and filling up the rest with rust joint mixture. Lead wire caulked cold was also used in the East River Tunnels of the Pennsylvania Railroad.

Tunnels are built with and without concrete lining. In the case of the Pennsylvania Tunnels the cast iron segments were lined with concrete to insure permanency, to strengthen them further against outside pressure and to guard against accidents. This concrete was placed with side benches to keep the trains in the center of the tunnel in case of accidents, and to furnish sidewalks for the workmen employed in track and tunnel maintenance.

Watertightness may be effected by two methods; first by a machine shop fit of the segments caulked with approved rust joint mixtures assisted by exterior grouting, as is the common practice, or second, the segments may be fabricated in accordance with bridge shop practice, so as to reduce their cost, and lined with concrete waterproofed by customary methods, assistance being given also by external grouting. Both of these methods are allowed for in the design of the steel tunnel lining. Whatever method of watertightness is followed, the tunnel segments should be rotated in erection so as to break joints and to prevent the intersection of four joint lines at one point and the bolts connecting the joints should all be drawn up tightly, as the tightness of the joints affects the watertightness of the whole structure.

The advantages of steel for tunnel lining as compared with cast iron are obvious. Sections of the same size and strength are much lighter and, therefore, more economical in transportation, handling and erection. Sections of the same weight would be longer and rings can be assembled with fewer pieces. Rolling processes being much more perfect than casting, machine work may be dispensed with and the segments made by ordinary fabricating methods. The toughness of the steel obviates breaking of segments due to uneven movements of the shield and the expense of their removal and replacement. The use of steel permits also the use of field rivets and in consequence the making of more nearly waterproof joints without caulting. Thirty feet of steel lining has been experimentally installed in an 8′ 8½″ tunnel of the Hudson & Manhattan Railroad. It is confidently expected that the advantage seen in erection will be further amplified by service.

PILE FOUNDATIONS. The Pennsylvania Railroad plans contemplated the use of screw piles placed through special bore segments to sustain the tubes at points of low stability and to prevent the tendency of the tube to rise by reason of its buoyancy. Only one, however, seems to have been driven as an experiment, as experience showed they were not necessary. Foundation bents were, however, placed through the lining in the reconstruction of the East River Tunnel of the New York Rapid Transit Railway through the fine sand region some 1200 feet long. These foundation bents spaced about 50 feet apart longitudinally consist each of two concrete-filled tubular steel piles 20″ in diameter, ½″ thick and spaced 7′ 0″ centers transversely. These piles were sunk to hardpan or rock by jetting through a 4″ pipe embedded in the center of the pile, were filled with concrete while being sunk and afterwards were capped with a concrete cradle formed around the bottom of the tunnel shell. The bents have been sunk to depths varying from 10 to 50 feet, the jet being assisted where necessary by hydraulic jacks butting against the roof by means of distributing timbers. The whole construction is one of the most permanent character and another proof of the wide extent of subaqueous tunnel construction.

Tunnel construction is not child's play. In its modern extent it demands engineering and executive ability of no mean order. Accurate knowledge of geological conditions and civil engineering skill must be combined with large mechanical experience and mastery of transportation methods to produce the most economical and permanent results; above all is there a place for rational use of the modern materials of construction.

The material for this paper has been drawn largely from the issues of the technical press for the last five years, chiefly the Engineering News, Engineering Record and Engineering and Mining Journal. Reference has also been had to D. McN. Stauffer's Modern Tunnel Practice and to the description of the Pennsylvania Railroad's New York Tunnels in the September, October and November, 1909, issues of the Proceedings of the American Society of Civil Engineers. The author claims no originality for the material; it has been his purpose to sort, classify and digest for the use and guidance of any master tunnel builder who may come after him. Perhaps it may assist some such builder in the construction of subaqueous tunnels under the Allegheny and Monongahela Rivers as a part of the rapid transit system of future Greater Pittsburgh.

SECOND VICE-PRESIDENT: Gentlemen, I am sure we have all been very much interested and feel glad that we have had the opportunity of hearing this paper. There are a number present, I have no doubt, who are able to give us some valuable information, and I will ask Mr. J. A. Nelson, Engineer, to open the discussion.

MR. J. A. NELSON: I came here to listen and to learn, not to talk. I do not know that I can add very much to what we have already heard. I am not a tunnel builder myself, but I have had occasion to look into certain matter in connection with tunnel building, and I can say in connection with the Elizabeth tunnel, to which the speaker referred this evening, that I was there this spring particularly to try to find out why they were making better records than most other tunnels. And several things in their practice in the West which differ from our practice in the East impressed themselves upon me.

First, in connection with this Elizabeth tunnel, the progress on that tunnel is made at the expense of cost. The total length of the tunnel is about five miles. It forms a portion of the Los Angeles Acqueduct, and it is by considerable the longest tunnel in that system. It is the desire of the Acqueduct Commission to get the acqueduct in service as soon as possible. So, the chief engineer of the work told me, he figured that they could afford to spend $100 a foot on that tunnel to have it in service at the same time as the rest of the acqueduct. As a matter of fact, they are spending between $40 and $45 a foot, and they are accomplishing this rate of progress by a system of bonuses to the men. They set a specified progress for ten days—I think that is the period into which they divide the progress—and if that progress is exceeded each man in the three shifts is allowed a certain amount per foot in excess of that amount. The result is that they can get the very best men. In fact, they have a long waiting list, because the wages received are so high. Some muckers draw pay at times as high as $150 a month apiece. Of course, that sort of thing is not usually the case.

The tunnel itself is driven in a rather soft granite. Some parts of it you might almost call rotten, it is so soft. But as a general proposition it is driven without timbering. About ten per cent. of its length is timbered. There are other tunnels in the acqueduct driven in very much softer material, and the tunnel in which the excessively high progress was made, I think 570 odd feet a month, was driven in very soft material.

The drills used are hammer drills and not piston drills such as we use principally here in the East. These drills have a combined water and air service through the center of the bitt. The results of competitive tests between that drill and the piston drill show that in solid rock, as they have in their harder work, the hammer drill will make about twice as much progress as the piston drill; but in the softer work the comparison is very much less than that, that is to say the hammer drill and the piston drill make about the same in real soft material.

The shots are all made by time fuses and the muck is transported by means of an electric locomotive with an overhead trolley wire. The diameter of the tunnel will average about 12′ and it is driven with a single heading without any bench at all. In the Catskill acqueduct I think the American record has been beaten this last month by making 488½′ in 29 days from one heading and bench. That tunnel is about 18′ 8″ in average diameter. That is driven by an upper heading and a bench. The tunnel is away under ground and is driven from very deep shafts, and where this record was made the shafts averaged 400′ to 700′ deep. This tunnel is to be lined with concrete, but not reinforced, as most of the work is in good hard shale which stands without timbering, a portion of it is in grit and a very short amount of it in sandstone. But this record was made in shale.

I would also say that I found a great deal of inventive genius being displayed toward the invention of machines which will drive tunnels in rock without drilling and blasting. I had occaison to watch the operation of one or two of these, two in fact, the Karnes machine and the Sigafoos machine. The Karnes machine consists of a large drill, really. It was working in a 6′ tunnel and it had a 6′ head. The principle of it is the same as an ordinary air drill, except that it is very large. The head is provided with loose knives with sharp edges. It rotates, and the whole principle is almost exactly the same as a large drill. The Sigafoos machine, on the other hand, instead of having a single head, has twelve small heads or stamps, which work alternately. They are drawn back by a cam, a large revolving disc carrying cams which drawn back these stamps and then they are driven against the heading by springs. That machine, instead of having sharp cutting edges has cast iron strips on the face about 1½″ wide, the Sigafoos idea being that you cannot cut rock, you have to crush it. That machine is driven by an electric motor. The Karnes machine is driven by compressed air. But as far as I could see the progress made was not such as would make a commercially practicable machine in either case. I asked both the inventors what they would do when they got up to such sizes as 18′ tunnels and neither of them had a very good answer to make, the general idea seeming to be that they would drive separate headings with each machine and blast out the center walls remaining between.

MR. J. C. WARNE: In the paper just read mention was made of the great expense incurred machining cast iron segments, such as were used in the Pennsylvania Railroad tunnels in New York. I happened to be visiting last summer where half of that contract was fabricated at the New York Car Wheel Co. plant, Buffalo, N. Y. The Master Mechanic, Mr. W. B. Watkins, designed and built special machinery for facing the segments of the tunnel lining and as near as my memory serves me, according to reports at the time, the operation was done in about twenty minutes for each segment, all segments being faced alike for size. As a consequent result of this machinery they were able to complete their contract far ahead of the scheduled time allowed for the work. I thought the reader of the paper might be interested to know this.

SECOND VICE-PRESIDENT: Can we hear from Mr. A. R. Archer, Engineer, with the Carnegie Steel Company?

MR. A. R. ARCHER: I did not come here expecting to say anything. I have had some experience in tunnel building around New York and I can confirm all Mr. Woodworth has said in his paper in regard to methods, progress, etc. He did not touch on costs, which might perhaps be an interesting subject. I was rather surprised to hear the costs given by Mr. Nelson for the Los Angeles tunnel, and presume they were for excavation alone. The total cost of the Hudson & Manhattan Railroad Tunnels ranged anywhere from $110 to between $300 and $400 per lineal foot, depending on the material encountered. That cost was solely for excavation and lining, not allowing anything for track work, interior finishing, etc. The cost of the Pennsylvania Railroad Company's tunnels complete, with everything except track and ballast, was between $800 and $900 per lineal foot, the respective sizes of the two companies' tunnels being 16′ 7″ over all and 23′ 0″ over all, which of course accounts for the difference.

In rock tunneling there is no doubt that the bottom heading method is more expeditious than any other. In bad rock, or rock in which a shaky roof may be encountered, it is best to use a top heading to permit of efficient timbering, a hard thing to do if the bottom heading is driven first. In moderate sized tunnels the bottom heading is usually full width. It is as easy to drive a heading 15′ or 18′ wide in one operation as to drive a small one in the center and afterwards enlarge it.

I think Mr. Woodworth did not have the information concerning some of the rock heading work done in New York under compressed air conditions. If my recollection is correct, in one month the rock heading on the New York side of the down town Hudson & Manhattan tunnel was driven from two ends at an average of 20′ each working day. Of course that is not anything like some of the records quoted for single heading work, but this was carried out in the Hudson schist, a very tough rock, under 32 pounds of compressed air. The blasting under these conditions has to be carefully done and the muck has to be handled through the completed tunnel behind, a distance of about 3-5 of a mile, in this case, in which the transportation conditions are usually very congested.

The speed of the shield work in soft ground is chiefly governed by transportation conditions. The best day's record of 62' was accomplished by herculean efforts on the part of the men employed and involved the handling of something over 200 tons of cast iron segments in the 24 hours, getting them in the tunnel and erecting them. That is something of an undertaking over a very narrow gauge track with two air locks through which the material had to pass.

Mr. Woodworth is a little in error on one point, the caulking groove is not usually planed, it is cast in the segment. So far as steel goes, there is no doubt that steel is the coming tunnel lining. My own opinion is that it will be developed rather as a thin shell to form a temporary tunnel lining inside which finally a reinforced concrete lining will be constructed. It has the additional advantage of forming a waterproof skin for the latter if care be taken with the joints at the time it is first erected. Under a design of that nature it would show favorably with cast iron in every respect as to cost.

SECOND VICE-PRESIDENT: We also have with us Mr. Richard Khuen, Resident Engineer, American Bridge Co., and we would be glad to hear from him.

MR. RICHARD KHUEN: My experience has been entirely above water and not under water, so I do not know that I can add very much to this discussion. I have examined the plan of the structural steel lining and I can say that it is entirely practicable and inexpensive.

One design that he shows would be particularly cheap, because it does away with nearly all machine work, and I think would be entirely efficient. These channels would be rolled with practically parallel flanges and the bending could be done without distorting them greatly. I believe that by bolting them with close spacing they could be drawn in contact so as to make almost a waterproof joint without much caulking, and possibly without needing a great deal of grouting on the outside. As to the rest of the tunnel discussion or the paper I have had no experience and can add nothing.

MR. NELSON: In connection with cost figures which I gave, perhaps it was a little indefinite the way I put it. The figures I gave were for excavation only and the cross section of the Los Angeles tunnel amounts to about 5 cubic yards to the running foot of tunnel. The Elizabeth tunnel is costing between $40 and $45 a lineal foot. Other tunnels, in rock, are costing about $30, and some of the tunnels in soft material where they can bore with augers is costing as low as $11 or $12. The Catskill acqueduct has about 10 cubic yards to the running foot and the cost per yard in rock there is about half of that cost at the Elizabeth tunnel.

SECOND VICE-PRESIDENT: I have a few things myself that I want to say. I would like to ask whether your experience has brought out the cost of the tunnel segments in some of this particular work you are describing. What is the cost per lineal foot or in pounds of finished material? Have any of the gentlemen seen any figures on that?

MR. WOODWORTH: About 2c a pound for the cast iron finished and delivered at New York.

SECOND VICE-PRESIDENT: Mr. Warne, will you describe the machines you refer to?

MR. WARNE: The machine used is what is known as a rotary planer, the segment to be machined was secured to a table similar to a planer table, and traversed between two heads, one on either side, like a lathe chuck, in which were a number of cutters about 1" square, firmly secured. As the castings passed between these rotating cutters the planing was done, and every segment made true and the same size. This reduced the cost of machining very much. The rotary cutter head is not a new idea. I have seen it used many years ago for facing off the ends of engine cylinders. However, the combination of the planer table with the rotary cutter head is a good one and produced the results desired.

SECOND VICE-PRESIDENT: I had the opportunity of reading the specifications for that New York tunnel line, if you will pardon a little personal experience, at the time I was in Altoona. The Pennsylvania Railroad Company had just planned to build a large foundry. The description of that foundry was published in last week's Railway Gazette and the management, in order to determine how much they should pay for the castings, put it up to us in Altoona to find out how much the Altoona people could furnish them for. I went to New York and conferred with the Chief Engineers of the tunnels, and they told me the quantity required, the rate at which they would have to be turned out, etc., and we found it would take a certain size foundry equipment to get the castings out as rapidly as the tunnel excavation would require them. Of course, we had to design special machinery to finish them, and I might say that the machine Mr. Warne describes is about what I had in mind, simply two facing mills working at the same time, and as the castings would pass between these mills their surfaces would be finished. We also arranged to have air operated clamps to hold them on the jigs and a double table so that one casting could be set on the jigs while the other was coming through the mills. I never saw what the Griffin people did have. That was locked up. But I guess we were all working on about the same scheme. That is why I asked the question of Mr. Woodworth how much the material really did cost. I know what our estimates were when we worked it up in Altoona and I think we were about the same as that.

If there are no further remarks, I will ask Mr. Woodworth to close the discussion.

MR. WOODWORTH: I do not think I have anything further to say, except that I would like to ask Mr. Warne what method was used for facing the segments?

MR. WARNE: So far as I know the same method was used for sides and ends. I did not have the privilege of seeing this special machinery in operation at the time the contract was being filled. I got word here in Pittsburgh of the record time being made on the job, and visiting Buffalo that summer I went to the company's works hoping to see the machine working, but I was denied admission. Last September I had the opportunity of seeing the machine, but it was inoperative, although I found it just as it had been described to me by those who had seen it working.

MR. HENRY GILG: My tunnel observation is limited to the North and East River tunnels last week. I marveled at the magnitude of them and I wondered how the work was accomplished. Through Mr. Woodworth's most excellent paper I have received some enlightenment and I want to move a vote of thanks of this Club for his very able paper.

The motion being duly seconded was carried by unanimous vote.

SECOND VICE-PRESIDENT: We will now have the pleasure of being entertained for a few minutes by Mr. W. H. Dithrich and Mr. David Stephens.

On motion of Mr. F. H. Stark a vote of thanks is extended to Messrs. Dithrich and Stephens for the pleasure they have afforded us.

ON MOTION, Adjourned.

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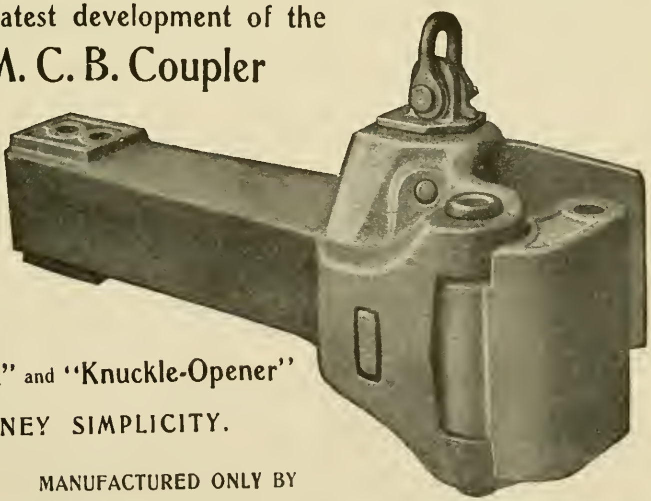

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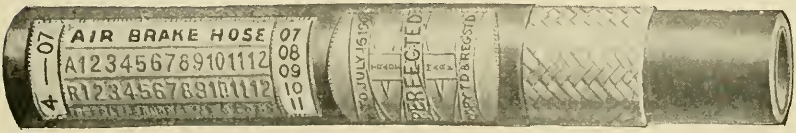

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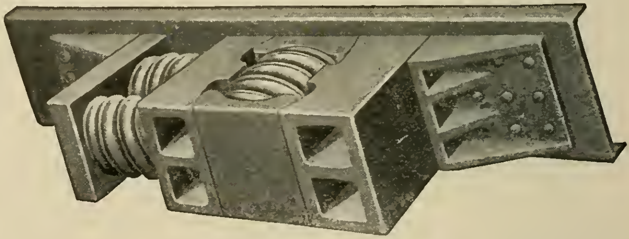

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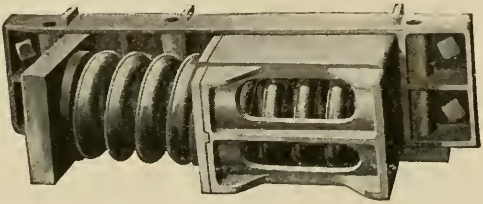

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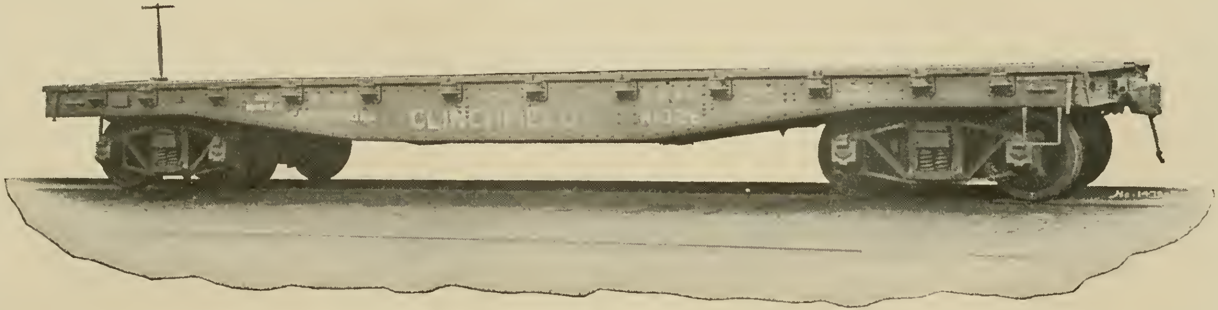

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Vol. IX. January 28, 1910 No. 3.

SUBJECT: "SUPERVISION TENDING TO ECONOMY IN THE OPERATION OF LOCOMOTIVES,"

By Mr. J. R. Alexander, G. R. F. E., Penn'a. R. R. Co., Altoona, Pa.

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Testimony From the Actual Users (4*)

¶ From time to time we have published statements regarding the merits of the "Modern Boiler Tube," i. e., the steel tube.

¶ In the last analysis, the success of any article must depend upon its own specific merits as evidenced by the experience of actual users.

¶ At the 1909 Convention of the International Boiler Makers' Association held in Louisville, Ky., there was a discussion of the report of the Committee appointed to investigate the respective merits of steel vs. iron Boiler Flues, and we quote from the published proceedings the remarks of the foreman boiler maker of one of the largest Railroad Systems in the country:

> "I do not think it is the duty of any committee to recommend whether steel or iron should be used. But when you appoint a committee on a subject and ask that committee whether steel or iron is best, they have certainly got to say one thing or the other. From my experience and from the figures and from the mileage and from the service that we have gotten from steel safe ends, it would be impossible for me to come down here and advocate iron, especially when my steel has run from twenty-five to thirty-five per cent more than iron in the engine. We had an engine that ran 40,000 miles with iron flues and we took it in the shop and applied steel safe ends, and the engine has run 72,000 miles, and she is running yet. So you see I cannot come down here and say that iron flues are as good as steel."

¶ The above instance is typical of the experience of many others.

¶ We formerly made both iron and steel boiler tubes.

¶ After some years of experience and observation we became convinced that the steel tube was the "MODERN BOILER TUBE"—and the manufacture of iron Boiler Tubes was abandoned.

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* This is the fourth in a series of announcements regarding the "Testimony From the Actual Users." Others have appeared in previous issues and will appear in later issues of this magazine.

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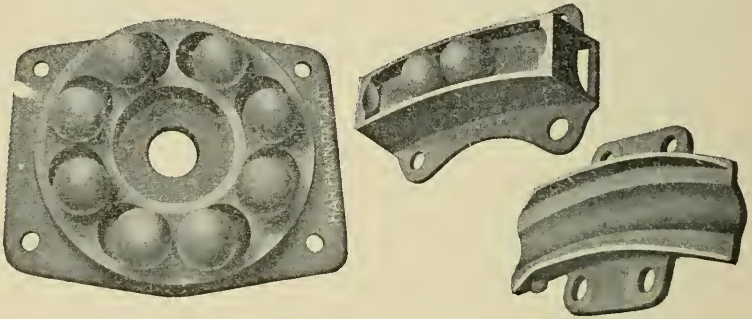

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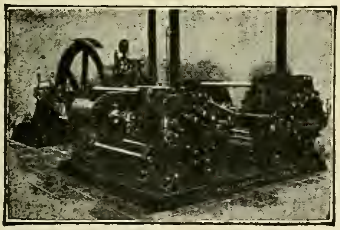

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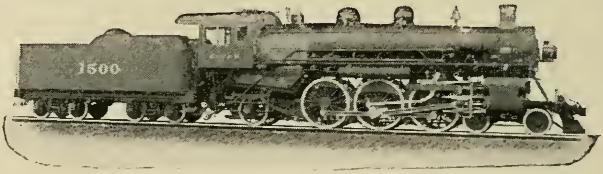

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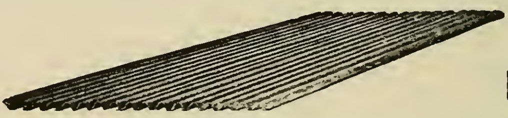

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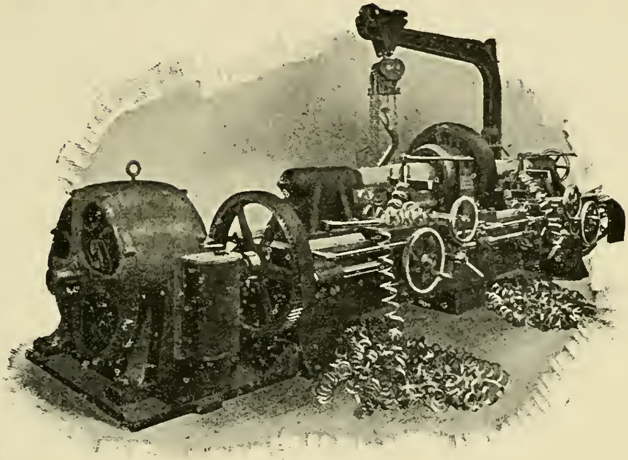

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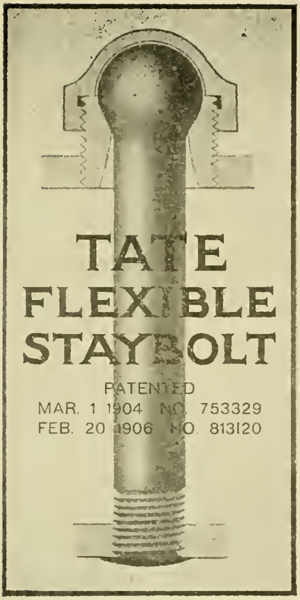

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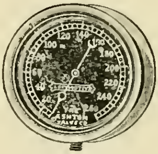

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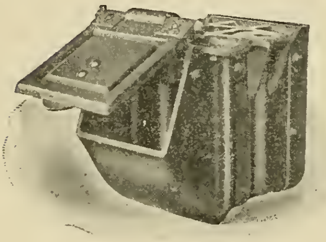

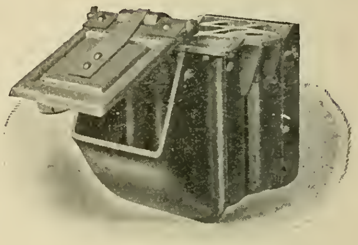

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Vol. IX.
No. 3.

Pittsburgh, Pa., January 28, 1910.

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING, JANUARY 28th, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

Boyer, Chas. E., Assistant General Car Inspector, Pennsylvania R. R. Co., Union Station, Pittsburgh, Pa. Proposed by Julius Krause.

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Dussel, F. E., Secretary and Treasurer, Transue & Williams Co., Alliance, Ohio. Proposed by C. E. Postlethwaite.

Griffith, W. R., Inspector, B. & O. R. R. Co., B. & O. Station, Pittsburgh, Pa. Proposed by W. P. Roberts.

Guthrie, John B., Sales Manager, American Steam Gauge & Valve Mfg. Co., Columbia Bank Building, Pittsburgh, Pa. Proposed by D. J. Redding.

Pitzer, Edwin H., Yard Master, Pittsburgh Division, Pennsylvania R. R. Co., 7939 Tacoma Street, Pittsburgh, Pa. Proposed by R. H. Mackenzie.

Publow, John, Chief Clerk to Train Master, B. & O. R. R. Co. Pittsburgh, Pa. Proposed by C. A. Richardson.

Shelhart, Frank, Assistant Storekeeper, Pennsylvania R. R. Co., Twenty-eighth Street Shops, Pittsburgh, Pa. Proposed by S. J. Gutierrez.

PRESIDENT: In due course of time these names will undoubtedly be favorably passed upon by the Executive Committee, after which the gentlemen will become members.

If there is no further business, I will ask Mr. John R. Alexander, General Road Foreman of Engines, of the Pennsylvania Railroad, to present his paper on "Supervision Tending to Economy in the Operation of Locomotives." Mr. Alexander needs no introduction to this audience.

SUPERVISION TENDING TO ECONOMY IN THE OPERATION OF LOCOMOTIVES.

BY MR. J. R. ALEXANDER, GENERAL ROAD FOREMAN ENGINES,
PENNA. R. R. CO., ALTOONA.

The subject to be presented to you this evening is a many-sided problem, when considered from the various statements tabulated by the railway accountants and statisticians, who are the artists that measure everything by figures, both as to quantity or quality and by comparison, relative to the operation of locomotives; and I find it difficult to analyze any one phase of the question without including numerous suggestions concerning various other operating conditions which would ordinarily come under the observation of a practical road man. However, among the many important divisions of the subject, there is no question but that the most expensive single item, other than wages, in locomotive operation, is the fuel account, a close second being the expense involved for either lubricating oils or tools and supplies. In this connection the statement is warranted that along these lines the performance of no other machine of equal importance can be so effected by the action of its operator, it being many times surprising in the extreme to note the disposition of both road and shop experts to charge to faulty design, engine failure, such as breaking of machinery, steam failures, etc., whereas, the trouble is more generally due to other causes, over which the operator should have entire control. It is, therefore, an interesting study as to how these several matters can be adjusted in order to bring about the desired efficiency, together with such economy as is consistent with the character of the service.

Among the many methods and schemes which have been suggested for securing economy in locomotive operation, I have had opportunity to look into quite a number, some of which depend for their success altogether on the faithful observance of an elaborate code of rules and regulations of great length; while such instructions are attractive when nicely framed and posted at engine houses for the guidance of road men, however, most of them fall short of securing the desired results, largely because of their impractical service requirements, as found by the men at the end of the monkey wrench or the oil can.

To my mind one of the rules or instructions that should be read frequently by most of us who are interested in promoting economy in locomotive operation, is one found among others posted at one of the prominent engine terminals in this territory, and which reads as follows:

"Great care in small things tends to greater success and economy than great knowledge."

During the transition period from the comparatively small to the modern types of heavy locomotives, much intelligent consideration was given to the design and construction of every detail, but for some reason little attention was called to the fact that such necessary changes in design also demanded the adoption of different methods of operation, as witnessed in the gradual but sure change from the assigned to the pooling system, at points where the cars to be moved require trains being held for power, especially since there has been a similar evolution in car equipment and train service conditions during the same period, all of which has resulted in the employe having less opportunity for self education along the proper lines than was formerly the case. As a result, it is possibly the most difficult problem of today to provide effective means for the proper education of enginemen and firemen in the various mechanical subjects about which they should have considerable knowledge to enable them to keep up with the procession and give satisfactory service to their employers. As a general proposition, educational work of this character for road men should be a part of the duties of the Road Foreman of Engines or Traveling Engineer, and to enable him to do so he should not be required to look after more than 100 road locomotives and crews. On roads or divisions where the number of locomotives is small, the Master Mechanic can take care of the road supervision, in addition to the shop organization, but on roads handling heavy traffic, thereby necessitating large shops and repair points, the results to be obtained will warrant the services of a Road Foreman or Traveling Engineer, who should have entire charge of the crews and also the locomotives while in service, reporting to the Superintendent and obeying the instructions of the Superintendent of Motive Power, or where operating under a departmental organization, to the Master Mechanic. In either case the Road Foreman should loyally support the Superintendent in all matters of locomotive performance and the Master Mechanic concerning maintenance. To this end he should be required to ride on each locomotive one or more times each month, besides giving special attention to certain locomotives and crews which are working under some unusual or unsatisfactory conditions relative to operation, maintenance, fuel, lubrication, etc., there being quite a difference between men being well informed and knowing what they should do and what actually is done, where they are not controlled by proper supervision.

The peculiarity and variety of duties performed by the Road Foreman or Traveling Engineer require the selection of a man in good physical condition, having considerable ability and good judgment along mechanical lines, and furthermore, to obtain results and keep the several members of the railroad family working in harmony, he must be somewhat of a diplomat, without being an all around good fellow. For this reason the men advanced to the position of Assistant Road Foreman of Engines or Traveling Engineer, should be a first class engineman, having not less than two years' road experience, and before being promoted they should have attained a certain amount of experience on special work in the Master Mechanic's department, relative to shop conditions, also grates, draft appliances and the use of steam indicators, or at least how to intelligently read indicator diagrams as to cause and remedy for certain conditions of valves and cylinders, thereby broadening their views and better fitting them to analyze mechanical problems from both a shop and road standpoint. The Superintendent and Master Mechanic should keep in training a limited number of available men who would be in line for advancement to the positions of responsibility referred to. This suggestion might also include the instructor of firemen, where this position is required. The instructor of firemen is necessarily a much younger man and should not be considered in direct line for further promotion without having experience as engineman in road service; however, to have desirable men always available for this position, firemen under certain regulations should be permitted to make application and be given shop experience as machinist helper, or inspector, under the direction of the foreman in charge. This suggestion is made advisably, knowing well the probable adverse criticism that such an arrangement would badly effect shop organization, on account of the frequent change in men, and the probable increased rates paid enginemen or firemen while so employed. Such comments are to some extent warranted, especially in case of a reduction of force in both engine house and road forces, where the regular shop employes might have to give way to the road men. On the other hand, shop hands could be considered eligible for promotion to the position of firemen, but this is also open to the objection before mentioned. However, if at all practicable, such an arrangement would be of great benefit along educational lines, and tend towards a higher efficiency of the entire force.

The desirable locomotive engineman of the present, or of the future, depends largely on the care exercised in the selection and education of the young men entering the service. In giving this matter some thought, it would appear that under certain conditions of train service, where large numbers of men are involved, an ideal arrangement would be the adoption of what might be called an "Employment Bureau," same being conducted by the Train Master or other representative of the Superintendent, who could give all necessary attention to the employment of men for both locomotive and train service. Under this arrangement where the applicant has satisfactorily passed the necessary examination as to physical condition, education, sight and hearing, he would be assigned to duty as a brakeman in road or yard freight train service, with the understanding, or agreement in writing if necessary, that the company in each case reserves the right to determine the department, either "CT" or "MP" to which the employee will be permanently assigned, at the same time permitting the brakeman after a certain period to express in writing to the proper officer, their preference for permanent assignment. This scheme would give the men opportunity while serving as brakeman to become familiar with train rules, signals and many other practical details relative to locomotive and train service, so that when actually transferred to the position of fireman they are in a measure prepared to perform efficient service, and in this way overcome the trouble and expense now experienced in breaking in new men as firemen. They would also be better prepared to withstand the hard physical labor involved in firing the modern type of locomotive. In this connection the statement is warranted that there is no excuse for the so-called front brakeman on the ordinary freight train other than to ride on the locomotive, observe signals and assist the fireman. In fact, on some roads it is now the custom to require the trainmen to fire the locomotive over certain portions of the division, for which he receives the fireman's rate of pay. However, whether or not the above scheme could be established, the brakeman in good standing should always be considered a desirable applicant for the position of firemen. The next best source from which to draw men for this position would be the sons of old employes or other well known citizens living along the line of road, thereby attracting to the service young men in good physical condition who would otherwise drift into farm work. Along this line it is believed heredity frequently has much to do with the success of young men in their chosen profession or vocation.

The present practice of hiring men for the position of fireman is for the Motive Power representative to size up applicants and examine such references as may be furnished, after which follows the required physical and educational examinations. When these several examinations have resulted satisfactorily, the man is ready to receive preliminary instructions concerning the actual duties of a fireman, and is or should be furnished with copies of the following instruction books:

A. Book of rules.

B. Block signal rules (when used).

C. Time table.

D. First aid to the injured instruction book (where provided).

E. Circulars of instructions relative to firing and fuel economy.

F. Air brake instruction book.

G. Steam heat instruction book (Not furnished until fireman is in line for promotion to passenger service.)

The new man then reports to the Engine House Foreman, usually with an arrangement to be sent out as an apprentice fireman on a freight locomotive, or in some instances it is the practice to at once mark the candidate up on the extra list as fireman, in which case the fireman instructor is required to ride with him until both the instructor and engineman are prepared to report favorably in writing to the Road Foreman, recommending that he be employed in regular service. Some investigation concerning this matter indicates that on some railroads the Superintendent and his staff officers have for years felt perfectly satisfied that after handing the man the instruction books above mentioned they had done their full duty and expected ever after to hear nothing but meritorious reports concerning his work. It is, however, gratifying to find that railroad officers now more generally recognize the importance of education of enginemen in order to insure proper maintenance and operation of the various appliances found on locomotives and cars.

The proper time to commence the training of new men is without question immediately after they enter the service, and it should then be carried along as a continuous performance to enable the men to keep posted on the frequent changes and improvements made to the rolling stock and its mechanical appliances. The matter of education from a railroad man's viewpoint should be strictly along the lines of definite instructions and supervision, with strong emphasis placed on "supervision."

For this reason I strongly recommend that the educational work be carried along under what is called the progressive examination system, whereby new employes first receive preliminary instructions, followed at the end of the first, second and third year with other examinations, progressive in character. It may be surprising to some to know the different subjects about which the railroad man must have more or less knowledge, some of which are as follows:

"Machinery," "fuel economy," "air brakes," "steam heat," "block signals," "safety appliances," "rules of interchange," "loading of long material," "transportation of explosives," "first aid to the injured," etc.

I am somewhat familiar with the progressive examination method of instructions as carried out on one or two different railroads, and find but little difference in their methods, except as controlled by local conditions. In some cases the first and second examination is made by a responsible division officer and the third examination conducted in writing, oral or both, by a committee consisting of different Master Mechanics and Road Foremen of Engines. At other points the examinations are all made by the Motive Power Instructor and the responsible division officer.

To make this method of instructions possible, the railroad or division should provide certain necessary printed matter or instruction books for the education of enginemen, firemen, trainmen and inspectors. In addition, there should be provided at large division terminals a thoroughly up-to-date mechanical instruction plant, containing suitable test racks and sectional parts, models, etc., of the various mechanical appliances as applied to locomotives and cars, all of which should be in charge of a competent instructor.

For railroads having a large number of outlying points where but few men are employed, the results desired may warrant the use of a fully equipped instruction car, it making periodical visits to these points in order to provide opportunity for every employe to become well informed on the different subjects. While the examinations referred to embraces various subjects, I will outline only the work as conducted for the air brake examination, under which arrangement the men when first employed would be sent to the instructor for general instructions and to be asked such questions as will bring out any previous knowledge they may have on the subject under consideration.

For new men a predetermined rating of 60 should be established, simply as a matter of record, to indicate their having no previous knowledge on the subject. At the next or subsequent visits of these men to the instructor, other ratings will be given, signifying what improvement, if any, has been made. Employes failing to pass the first progressive examination should be granted a second at the end of a 30 day period, and if again unable to pass, still another examination should be given at the end of the next 30 days, and if advisable a fourth opportunity should be permitted. If then not able to obtain the required minimum rating the man should be dropped from that particular service.

For the progressive examination employes are examined either separately or in classes composed of a limited number, of, say, 6 to 10 enginemen or firemen, as facilities at hand will permit. In all cases the instructor places the name of each man on a standard blank, as shown on accompanying sheet "A," and from time to time as the work is carried along, checks up the knowledge of the men by a suitable mark or symbol (X) under the several headings, each having a certain predetermined value, and after the class is dismissed the total number of demerit marks are added together and the sum substracted from 100 to find the percentage earned. It should not be understood that each of these several (X) marks represent incorrect answers to either a written or oral question, but rather that one or more questions grouped together have not been understood, the marking being determined by the importance or predetermined value of one or more of the several questions.

In the case of enginemen, they should be given two ratings, one to show their knowledge of the different parts of the apparatus, the other to indicate proficiency in handling air brakes in train service. This plan seems to be just and reasonable, as there are a number of enginemen who are very successful in handling air brakes in train service, but who are not able to obtain the desired maximum rating by offering a satisfactory explanation of the mechanical construction of the various parts.

For train proficiency the rating should be as follows:

Sixty indicating bad, 70 fair, 80 good and 90 excellent.

In knowledge of mechanical apparatus enginemen assigned to passenger, freight or yard service should be required to obtain a rating of not less than 85, which would indicate that they are well informed as to the construction of parts and how best to operate the brakes in case of accident or under unfavorable conditions. The only exceptions to the above ruling would be for certain yard shifting operations where air brakes are not used on trains, for which a lower or minimum rating may be established at the discretion of the Division Superintendent. This would signify that the man had no knowledge of construction of apparatus beyond the location and arrangement of the different valves, how to apply and release the brakes and to couple up and disconnect the brake connections.

Railroad

Instructed in Motive Power Instruction

Car at .... 191 ....

NAMES	Occupation	Rating	Pumps and Governor	Main Res. and Pressure	Train Pipe and Pressure	Triple Valve	Aux. Reser. and Brake Cyl.	Brake Valve	Instructions	Train Air Signal	Proficiency in Service	Steam Heat
A	B	C	D	E	F	G	H	I	J	K	L	M

"A"

In the same way, firemen after one year of service, should be examined on these different subjects and required to obtain a predetermined rating as to knowledge of mechanical parts. At the end of the second and third year they should be re-examined with a correspondingly higher rating required, the third year examination being considered final for promotion to the position of engineman, for which the minimum rating should be 85% of a possible 100. Where the men are not advanced for any considerable time, or when enginemen are demoted and again advanced, another examination may be demanded. The final examination should be both written and oral, for which a list of printed questions may be prepared. Firemen should only receive a rating in train proficiency when actually promoted to the position of enginemen.

When trainmen receive instructions on air brakes, the work is carried along in the same manner as has been explained for enginemen and firemen, but as they are not examined on the air pump or other engine equipment, they should be started with certain demerit marks under each of these several headings, indicating either an entire failure or that no examination on this particular part had been made. Therefore, trainmen receiving no demerit marks under any of the other headings on the special blank referred to, could only make a maximum rating somewhat below that of the engineman. There should, however, be a minimum rating established for all passenger and freight trainmen.

Enginemen should be re-examined on necessary subjects not less frequently than once every two years in order to be eligible for promotion under seniority rules, as from one class or grade of train service to another, yard to road, freight to passenger, or when any radical changes are made in the equipment.

Engine air brake inspectors employed at terminals should be examined along the same lines as enginemen and the same rating should prevail, and the car inspector should be examined and rated along the same lines as trainmen.

All employes passing the examinations as required by the proposed regulations should stand equal, any preference being determined by their efficiency record, and furthermore, I would make special mention that in all cases of meritorious service, or infraction of rules coming under the observation of responsible officers, should be the subject of investigation and such recommendations and action taken as would insure making a change of rating from lower to higher, or vice versa, as the case may warrant.

Instruction books on locomotive machinery very seldom cover the detail arrangement of any particular class or kind of locomotive. The information required to sufficiently educate road men should be edited and issued by the different railroad companies in the form of circulars or general notices, as for instance, one to cover instructions on parts of machinery on locomotives equipped with link motion and another for Walschaert valve gear, etc., so that in the event of radical changes being made in the equipment it would only entail a change of some one particular circular.

There does not appear to be any necessity or demand for the compulsory attendance of enginemen and firemen to general lectures on subjects of interest to these employes, although when educational in character they are sometimes considered desirable to attain results. While this to some extent may be true, I believe the greatest good to the greatest number will be secured by means of specific instructions issued by the company by circular or general notice, together with such facilities as can best be obtained through a properly equipped room or car.

Where the facilities herein outlined are provided, there does not appear to be any good reason for issuing printed instruction questions or issuing proficiency certificates showing results of examinations, although the latter information is absolutely necessary as a matter of record, yet there are considerable objections to having these cards issued to employes.

It should hardly be necessary to say that with any method or examinations devised for the safety of train operations, the work is only half done when not followed by proper supervision, and whether the instructors hold the title of Road Foreman or Traveling Engineer, they should be provided with necessary authority to see that all persons interested perform their duty intelligently and thoroughly along the lines indicated by the rules and regulations authorized by the proper authority. Furthermore, these men should not be burdened with much clerical work, but be free to give their entire time to instruction and improving the methods of the men employed in handling and firing locomotives. It is essential, however, for the superintendent or other proper officer to know each day the movements of their representatives, and for this purpose a suitable blank should be used, that is, one that can be easily filled out on the road, and when forwarded and received by the proper officer, will serve to show the daily movements of the Traveling Engineer or Fireman Instructor, and also for an efficiency record of engine crews when working under the assigned system, or separately, where the pooling system is used.

Sheet "B" shows a blank for this purpose which is herewith submitted for consideration.

In the question of fuel economy there are many important details that largely effect the showing on the performance sheets about which the road men have no choice or responsibility, except to make recommendations to the powers that rule, covering any matters coming under their observation. For instance, the number of locomotives in service above the actual requirements, represents unnecessary investment and expense in maintenance and additional cost of coal consumed by locomotives being held too long on storage tracks, and again, there is more fuel wasted from unnecessary holding of trains on sidings from schedule requirements and the stopping of heavy trains where same could be avoided, than can be saved by the concerted efforts of the engine crew during the entire trip. In this connection careful tests recently made indicate that not less than 15% of the total amount of fuel supplied to locomotives perform no functions in moving trains, but disappears in the incidental ways just mentioned, or remains in the fire box and is removed at the end of the run.

Many devices for saving coal, including superheaters and mechanical stokers, have been tried out on various railroads, but few, if any, have shown sufficient merit to warrant their general adoption, especially as the small saving usually accompanying such appliances must be considered against the cost of maintenance and the liability of their being out of order and consequent loss in efficiency of the locomotive. It is also true that a thor-

________________ RAILROAD

EFFICIENCY REPORT

ENGINEMAN

DIVISION
LOCOMOTIVE
REVERSE LEVER
THROTTLE
INJECTOR
SIGNALS

DATE
TRAIN
FROM TO
AIR BRAKE
TOOL EQ'M'T
REMARKS ________

NOTE 1=GOOD 2=FAIR 3=BAD

……

EFFICIENCY REPORT

FIREMAN

DIVISION
LOCOMOTIVE
CONDITION OF FIRE
METHOD OF FIRING
SMOKE
SIGNALS

DATE
TRAIN
FROM TO
CLEANLINESS
COAL
REMARKS

NOTE 1=GOOD 2=FAIR 3=BAD

"B"

oughly practical and successful mechanical stoker which will convey coal from tender into the fire box would be a most important development, as under present conditions the efficiency of the modern locomotive is determined largely by the physical ability of the fireman to do the work.

An important factor in economizing is obtained by giving careful attention to draft appliances and grates, also dampers where these fixtures are provided. The bad condition of valves, piston packing, etc., are sources of waste of steam, and therefore coal. All of these parts require periodical examination to insure their being in proper condition, and furthermore, traveling engineers should be required to know that enginemen properly report on regular form at engine terminals all defects to parts that represent steam losses, all of which can best be detected and located while locomotive is in road service.

Road supervision of locomotives and trains should include the entire 24-hour day, and where the different locomotives or men cannot be seen within reasonable daylight hours, arrangements should be made to provide supervision for those engaged on night runs.

Among other schemes, what may be termed road trials should be conducted covering different kinds of service, especially where large amounts of coal are consumed by locomotives handling maximum tonnage trains over controlling grades. On such trips the coal supply should be carefully weighed, and preferably placed in bags on the tender. A trial of this kind should be made first with the average engineman and fireman, then repeated by the Road Foreman of Engines and Fireman Instructor handling the locomotive, with the idea of producing the very best results. The advantages of trials of this character are:

First—The quantity of coal required per gross ton, including the weight of car and lading, is determined accurately with the best handling and firing of the locomotive.

Second—It is a practical demonstration under either the draw bar pull or adjusted tonnage method of making up trains, and can be used from time to time as a basis of checking up the practices of the different engine crews, and with the use of counters the amount of coal consumed. To do this, the instructor carefully estimates the average weight of coal contained on the standard shovel and by carrying this device in the hand he can easily tally the total number of shovelfuls of coal, which times the pounds per shovel will give the total amount of coal used during the trip. The results obtained by this method should be compared with those secured from the weighed coal tests, and they will also be found to compare favorably with the monthly or other reports which usually come to hand several months after date.

Opinions differ among enginemen and others as to the most economical method of handling the reverse lever and steam throttle valve; some believe the reverse lever in long cut-off and throttle valve partly closed is better than short cut-off with throttle wide open. These represent extremes, neither of which can be followed successfully over the entire division, but a combination of the two must be used to obtain economical results. With maximum tonnage trains over controlling grades, short cut-off and full throttle must be used, at many other points reverse lever can be run at a slightly shorter cut-off than 25% with throttle only partly open, it not being necessary to maintain boiler pressure in the steam chest under many such conditions, thereby insuring better valve and cylinder lubrication and a free working engine, although with partial throttle the steam may not be quite so high in temperature.

Records of coal supplied to locomotives on the per ton mile basis cannot be satisfactory where tons considered are those of lading only. These estimates should be based on consumption per gross ton mile, that is, weight of car and lading. Even this is incorrect where some adjustment factor is not used, as the resistance in gross tons in empty and loaded cars differ materially with the same draw bar pull on the locomotive. In other words, the measure of work performed is the total tonnage moved at the most economical, or the desired speed.

Level firing is recommended. The firing to be heavy or light as the service may demand, as no one kind or depth of fire will give the same results under various conditions. These questions must be worked out by the judgment of the engine crew or the instructor. From a number of comparative tests made to show the economy of different methods of firing, it would appear that a large bank or hump fire is wasteful of coal, although a small bank may be used with about the same economy as the level fire; the latter method, however, insures a cleaner fire during the entire trip. It will be found that the "light fire" man who places most of the coal on the sides and across the back of the fire box can maintain steam pressure with the door always on the latch, because not all of the air is required to go through the grates to keep the fire open. Therefore, a large portion of air can be admitted at the door above the fire as an aid to complete combustion. In fact, a closed door indicates a too heavy fire requiring the draft to tear it up to permit sufficient quantities of air to pass through. However, with either the small bank or level fire the door must be opened and closed on the latch between each shovelful, and also remain on the latch between fires or until the low volatile gasses are consumed. Sketch "C" will illustrate the different methods of firing herein referred to.

At terminals there are usually one of two methods followed when banking fires, that is, front or back banking. The front method means that the live fire and coal is placed next to the flue sheet and this is believed to be the most desirable, except where it is the practice to brick off the front portion of grates. There is nothing saved in banking fires in the large modern type locomotives for a period of 24 hours or more, as where this is done it is generally necessary to again clean the fire before leaving the terminal, so that the amount of coal required to keep the fire in good condition and to build it up the second time is greater than the amount required for a new fire.

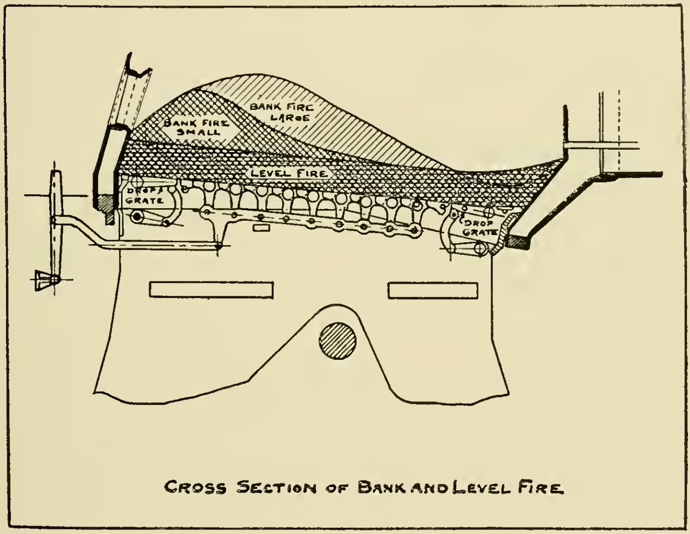
It is estimated that approximately 2000 lbs. of coal is used to clean and bank a fire for a period of 24 hours. To build up a fire after cleaning 600 lbs., and for a new fire until 80 lbs. steam has been obtained 1200 lbs.

It might not be out of place here to say that the work of a locomotive is to move cars at certain speeds, and for road service it should be so employed from 18 to 20 hours during each 24 hour day, as under favorable conditions it is believed 4 to 6 hours is sufficient time after arrival at a terminal for cleaning of fires and making all light running repairs, and 8 to 10 hours for thorough inspection and repairs at each periodical boiler wash period. At this time the more supervision and care exercised concerning attention to details will show economy by reason of the less number of locomotive failures in train service and a greater total mileage between shoppings for repairs.

The following are some of the details incident to fuel economy requiring careful supervision:

To keep boiler clean and free from scale and the flues clean throughout their entire length, as well as at the ends.

Draft appliances, in connection with air openings in the ash pan and size of exhaust nozzle.



CROSS SECTION OF BANK AND LEVEL FIRE

"C"

The proper handling of reverse lever and steam throttle valve, to see that the former is at all times placed in the proper working notch and that the latter is full open when engine is working under maximum conditions over ruling grades.

While on the road to watch the method of firing and enforce instructions relative thereto, the details of which depend largely on the quantity of coal furnished.

Proper operation of injectors to maintain uniform height of water in boiler at such times and places as will consume the least amount of coal and loss of steam pressure.

Injectors should be shut off during the hard work of accelerating speed when starting trains. On the other hand, the opposite extreme must be avoided whereby large quantities of water are admitted into the boiler when steam is shut off and fire not burning brightly, at which time the circulation of water is sluggish. Good judgment on the part of the instructor will find the happy medium that gives the best results. Attention might also be called to the frequent cases of excessive waste of water and coal due to unnecessary blowing off of steam at safety valves. These valves on large types of locomotives carrying 200 lbs. steam pressure will blow out about 75 lbs. of water per minute.

The prevention of excessive black smoke by proper firing with either the one, two or three shovelful method, the best results being obtained by swinging the door in a leisurely manner between each shovelful and placing it against the latch between fires, or until the low volatile gasses are consumed.

To arrange for locomotive receiving full supply of coal at points requiring the shortest haul of this material in cars, and to have tenders at least nearly empty when sent to shop for repairs.

To avoid overloading of tenders and the subsequent loss due to coal falling to the track, also keeping the deck plate tight around boiler and sides of the cab for the same reason.

To avoid unnecessary or too frequent cleaning of fire and not enough or too frequent use of the scraper or shaking of grates while locomotive is working on the road.

The proper wetting of coal on tenders, which should be done both for the comfort of the men and to improve the condition of fuel.

Locomotives should be delivered on receiving tracks at terminal with full supply of water in boiler to avoid the excessive use of injectors to fill boiler after fire is cleaned or removed.

In this connection I believe a mistake is made at many otherwise modern engine houses by having the coal and sand storage facilities placed on the receiving tracks. It frequently occurs when locomotives are loaded on the inbound movement that they must be returned to have the coal or sand removed in order to make necessary repairs, and at other times the locomotive must be moved against the traffic to the coal wharf for full supply after standing an unusual length of time on storage tracks.

The economical operation of locomotives also demand careful supervision of the methods employed in handling lubricating oils, for surprising as it may appear, there are many men who believe good lubrication can best be obtained by quantity rather than quality.

The ideal conditions insuring perfect lubrication on locomotives is to have a lubricant, the globules of which will be sufficiently strong and the mechanical arrangement such that the load carried on the bearings will not force out the film of oil, thereby permitting metallic contact. However, the technical side of this subject is beyond the scope of this paper, it being enough to say that as a general proposition railroads are using lubricating oils of a character that fully meet the requirements of the service.

Responsibility for caring for lubricating oils usually commence with the Master Mechanic, who is required to provide arrangements at engine terminals for storage of large quantities of this material. Where large quantities of oils are handled, tank storage should be employed, the tanks being placed in vaults, but elevated above the floor so that leakage can easily be detected. When barrel storage is employed frequent examination is required to prevent excessive loss due to leakage. At outlying points were oil in barrels must be stored, same should be protected by shed covers.

Lubricating oils are furnished to enginemen or inspectors on receipt of a proper check for the amount authorized on oil limit schedules, which are issued by the Superintendent of Motive Power, Master Mechanic or Road Foreman of Engines, it being determined from previous experience the quantity that should be used for each 100 or more miles run. The same authorities also determine the amount required to properly saturate wool or cotton waste when prepared for packing journal boxes on locomotives and tenders.

The method usually followed is to provide either the engineman or the locomotive with a 10 to 14 lb. can for necessary supply of engine oil, same having in some cases a receptacle for carrying a small amount of rod cup grease, and another can of from 4 to 6 lbs. for a supply of oil for use exclusively in valves and cylinders.

Engine crews on arrival at terminal should be required to take the supply cans to the oil house, or other designated place, or store them in the boxes on tender and deliver the keys to the Engine House Foreman, as conditions at each terminal may demand. Before leaving terminal, engine crews are usually required to secure the supply cans from the locomotive or at the oil house, and have them refilled to the amount governed by the oil limit schedule, which if carefully determined represents the amount that should be used, but in case oil not used is returned, the amount may be credited to the supply for the following trip. Where locomotives and cans are assigned to regular crews, the practice is generally followed to permit their keeping on hand a small amount of extra oil saved from the daily trip allowance, the total amount carried being controlled by the limited size of the supply can. In case it becomes necessary to furnish additional oil while on the road by reason of journals heating, etc., oil limit schedules should specify the amount to be furnished. Checks for excess oil should state in writing on the reverse side cause for drawing such excess oil, this check to be made in duplicate and signed by the Engine House Foreman and copy sent to the proper officer for investigation as to cause. Hard grease for rod cups should be handled in the same manner, and enginemen held responsible for the adjustment of plungers and proper lubrication of main and side rod bearings.

Engine house people are generally held responsible for the care and maintenance of locomotive and tender journal lubrication. The methods and amount of packing used in journal boxes being prescribed by properly authorized instructions and furnished to inspectors on receipt of regular blanks signed by the Foreman, who should be held responsible for the economical use of this material, including the reclaiming of oil and waste from packing in good condition removed from journal boxes.

With the modern type of equipment opinions differ as to the quantity of different oils required to insure proper lubrication. The facts are, that the records of a number of railroads, or where results are compared between different districts on the same road, indicate clearly that tthe consumption varies greatly per 100 locomotive miles run.

For the lubrication of valves and cylinders, it is believed entirely satisfactory results can be secured when using a sight feed lubricator in good condition, with a consumption of approximately 1 lb. valve oil to an average of 80 miles on passenger locomotives and the same amount for 50 miles on freight locomotives. For yard and local shifting service the oil limits should be determined on the hour basis instead of miles. The difference in miles run per pound or pint in the various kinds of service referred to depends upon the piston speed and tonnage hauled.

Enginemen and firemen should be instructed concerning the character of the lubricant and understand that perfect cylinder lubrication does not depend altogether on the speed at which the lubricator is working, but rather on starting the lubricator 10 or 15 minutes before leaving a terminal in order to thoroughly lubricate all parts before using steam, the feed valves being adjusted to supply from 2 to 6 drops per minute for each cylinder and 1 per minute to the air pump, depending on the character of service.

It should not be necessary to say that proper lubrication cannot be obtained where an excessive amount of water is carried in the boiler. Some one has stated with a great deal of truth, that too much water in a boiler is pretty nearly as bad as not enough. In any event, there is no question but that the frequent washing of the valves and cylinders is one of the common causes of imperfect lubrication and consequent excessive use of lubricating oils. Too much water in the boiler is also frequently noticed when locomotives are standing on engine house tracks.

Careful supervision should overcome the trouble frequently experienced from the practice of mixing cylinder oils with engine or other oils, which is without question a bad practive, whether same is used for cylinder lubrication or in rod cups, for the reason that when the combination oil is heated or well shaken up, its lubricating qualities are very much impaired.

Machinery oils, of the kind with which I am familiar, must be used exclusively on bearings having a low temperature, such oils not being suitable for use on hot parts. A good lubricant for machinery, however, is one that will best prevent the bearings heating above what is known as running temperature.

The Road Foreman of Engines and his assistants should be held responsible for seeing that enginemen follow the best known methods of oiling machinery and journal boxes on their locomotives for the different kinds of service. It will many times be noticed that some men will oil their engine the same for either a long or short run, or that certain men after oiling carefully at the terminal will run over the entire division using very little or no oil on any part of the machinery, while other men will oil around several additional times under the same conditions. The former method indicates clearly that the engineman knows what is required from lubricating oils, while the other man's action clearly indicates a lack of interest in his business. As both men no doubt had the same opportunity for education, the improvement in the latter can only be attained by rigid supervision on the part of the instructor.

When machinery is maintained in fairly good condition and all parts well lubricated, it is not necessary to again lubricate working parts of locomotives, other than valves and cylinders, between terminals, or for continuous runs of from 150 to 200 miles for passenger, and where time on the road is not excessive 100 to 150 miles for freight locomotives. Under these conditions they should be expected to make a general average of 20 to 25 miles per pound or pint of engine oil.

Driving box lubrication is obtained by means of a supply of oil from both top and bottom of the journal, while tender and car journals depend altogether on the supply of lubricant from the under side. In either case, however, it is essential that the packing in journal box cellars be maintained in good condition, and to this end it is necessary that a good quality of wool waste, or other suitable material, be provided and same prepared for use by being submerged in oil for not less than 48 hours, after which the waste should be drained of free oil in excess of 4 lbs. oil per pound of waste, and furnished to inspectors well loosened up and not wrapped up tightly in balls.

In packing journal boxes it is a great mistake to have the waste contain too much free oil, as this makes it impossible to pack sufficiently tight under the journal to prevent pounding down after locomotive or car is in motion.

Dust guards at back of journal boxes should be maintained in good condition and the packing kept firmly set up to the journal at the rear of the box. At the sides the waste should not be allowed to extend above the center line of journal, for if the waste is allowed to pack against the rising side of the bearing it will soon become glazed and act as a wiper and is very likely to clean the journal of free oil, thereby preventing it from passing under the bearing.

The best results and with considerable economy in the amount of oil and waste, will be obtained by having locomotive and tender journal box cellars not more than 2¼″ deep, as experience proves that capillary attraction will not bring sufficient oil through waste from a greater depth.

To avoid much of the trouble experienced from hot journals and excessive consumption of material, inspectors should be carefully instructed and permanently assigned to the care of packing in locomotive and tender journal boxes. This work is oftentimes slighted, especially when pushed for power the engine dispatcher anticipating engine being ready had offered same to the "CT" department.

When locomotives are in shop for such repairs as require the removal of wheels, it should be known that journals, brasses, etc., are in good condition, the oil passages open and the packing in proper condition before wheels are replaced. To insure perfect lubrication and a proper running journal, the driving box bearings should be bored approximately 1-64″ larger than the journal.

When giving attention to the waste on top of driving boxes, care should be exercised to arrange same so that oil does not escape too freely through the oil holes to the hub face of box or to the shoes, and to prevent oil from syphoning over the sides of the box. Wick feed through the oil passages in locomotive journal boxes is to be recommended.

Driving or other journal boxes fitted for oil lubrication and running cool should not be lubricated with valve oil or other heavy greases, as the bearings must become heated to a high temperature before this oil or grease will feed to the journal. This in many cases will delay too long the lubrication and be the cause of excessive heating.

Instructions covering the following small details if properly enforced bring about large revenue returns.

When oiling around, do not overflow oil cups, oil holes or guides, as it does no good and it is both wasteful and expensive.

When guide or piston rod cups are equipped with adjustable feeds, they should be open and adjusted before leaving terminal and closed at end of each day or trip.

The feed of lubricators must not be increased when nearing the end of a run for the purpose of draining out the surplus oil. Neither must oil be allowed to escape at the drain plug when draining lubricators previous to refilling.

Machinery oil cans must be kept in a location on the locomotive that will not allow the oil to become heated above 65 or 75 degrees, as the lubricating properties of the oil is very much impaired when heated to a high temperature.

It is also essential when refilling lubricator with oil to see that the operating valves are closed and again opened properly and that sufficient time be allowed to insure the condensation to fill the chamber and raise the oil to the top of the oil pipes before the feed valves are opened. Some care in this direction will prevent most of the troubles with lubricators, and in addition, sight feed glasses will remain clear and there will be no loss of oil by syphoning.

To insure good machinery lubrication with a minimum consumption of oil, it is essential that journals not in service should be coated with some suitable material to avoid rusting and this mixture should be thoroughly cleaned off before placing them in service. Journals must also be trued up properly before leaving the machine shop.

It is not good practice to change a partly worn bearing from one journal to another.

Proper templates should be furnished inspectors in shops corresponding to the various size journals to insure proper bearings being applied.

Grease has recently come into general use for the lubrication of main and side rod bearings, and without a question of doubt the results obtained have been entirely satisfactory, although the consumption in most cases is largely in excess of the requirements. Grease compound as a lubricant for driving wheel journals has been used exclusively on quite a number of locomotives on many different railroads and in my opinion where the automatic lubricating device is properly designed and applied, and the proper grade of grease furnished, this arrangement will be found the most satisfactory and economical method of lubricating driving wheel journals on the large modern type locomotive.

Lamp burning oils are furnished to locomotives for headlights, torches and lamps. The keeping of headlights or torches in good condition is perhaps the most essential requirement for preventing wasteful consumption of this material. The practice of allowing lamps to burn during the hours of daylight, and when not required, is both wasteful and contrary to good railroad practice.

Lamp oils should not be furnished for use in locomotive or train service after having been carried in stock for a period of nine months or more, as during that time the value of the compounds will become very much impaired.

Another interesting detail in locomotive operation requiring supervision relates to the question of tool equipment, and it may be of interest to some few "old timers" who may be present to say that there is little if any difference in number and kind of tools required for the modern locomotive than was the case years ago when smaller locomotives were in general road service. In fact, if any difference does exist the reverse is true, as 15 or 20 years ago engine crews required a greater variety of tools and other supplies than at the present time, as it was then considered necessary to equip all locomotives with screw jacks, car replacers, pinch bars, wrenches for eccentric set screws, cylinder piston packing nut wrenches and small valve trams, some of which the men of today in charge of locomotives would not need, and possibly would not know how to use should they be provided.

Of the various schemes suggested and tried out on various railroads, no two would seem to fit in with conditions existing on any other road, so that any information at hand will only serve as an aid in preparing a tool list under known conditions. However, the number and kind of small tools to be furnished should be determined largely by the work required of the engine crews for the maintenance of machinery as effected under either the assigned or pooling system.

Where storage track facilities at engine terminals will permit, engine crews of assigned locomotives are generally willing and should be expected to make such repairs as adjustment of driving box wedges, keying rod brasses, the keeping in condition of headlights, lamps, etc., and all safety and cotter pins in bolts and keys, and in addition to report intelligently defects of every character to the machinery, as well as the true condition of tool equipment on arrival at terminal. When working under the pooling system the best results will be obtained by holding engine house people responsible for making all repairs, only requiring enginemen to make out proper work reports concerning defects to machinery, including the condition of tool equipment, on arrival at each terminal.

The list of tools and furniture shown on sheet "D" will serve to show what articles are considered necessary.

In reading over the list of tools it should be understood that the several articles in group "A" are those considered as fixtures and remain permanently on the locomotive.

Group "B" refers to firing tools and group "C" the small tools, cans, lamps, etc., for which engine crews are usually held responsible, both while on the road and at terminal.

One of the most common methods followed in the care of tool equipment is to furnish enginemen with the required number of small hand tools, lamps and oil cans, and charge such articles as personal property. This method has been found to be both economical and satisfactory where the proper facilities are provided at engine terminals to permit engine crews to remove their kits, as they are sometimes called, to some convenient room, where they are kept under lock and key until wanted for the following trip.

This plan, in connection with an individual record of each article furnished, is possibly the most ideal one for caring for locomotive tool equipment, but unfortunately this scheme is not always practicable on account of the arrangement of tracks at terminals.

At other engine terminals it is the practice to require enginemen and firemen on arrival at receiving tracks to place all tools and oil cans in storage boxes on locomotive or tender, and after locking same, to deposit the keys in the office of Engine House Foreman, where they remain until wanted for the next trip, when the engineman or fireman secures the cans, taking them to the oil house for the regular supply of lubricating oil and waste. At still other points when locomotives arrive the oil cans and lamps are removed from the locomotive and taken to the oil house by the engine crew.

"D"

	KIND.	NUMBER		
		Pass.	Frt.	Shift.
	Group "A" Furniture			
1	Blocks, Crosshead....	1	1	
2	Boards, Coal (Set)..	1	1	1
3	Boxes, Medical	1	1	1
4	" Seat	°	°	°
5	" Tin	1		1
6	Chimney, Headlight..	1	1	2
7	Clamps, Valve.......	1	1	1
8	Clip, Order	1	1	1
9	Cooler, Water	1	1	1
10	*Cord, Bell	2	2	2
11	" Whistle	1	1	1
12	*Curtain, Cab, Back..	1	1	
13	* " " Side..	2	2	
14	Flags, Green	2	2	2
15	" Red	1	1	1
16	" White	2	2	2
17	Flag Holders	4	4	4
18	Hose, Brake	1	1*	
19	* " Injector squirt	1	1	1
21	" Steam	1		
22	Knuckle, Extra	1	1	
23	Lamps, Cab	1	1	1
24	** " Classification.	2	2	2*
25	** " Marker.......	2	2	2*
26	*Padlock	1	1	1
27	°°Pole, Push		1	
28	°°Rope, Tank		1	1
29	Seat, Drop	°	°	°
30	*Shield, Window	1	1	
31	Torpedoes	6	6	6

	KIND.	NUMBER		
		Pass.	Frt.	Shift.
	Group "B," Firing Tools.			
1	Lever, Shaker Grate.	1	1	1
2	Pick, Coal	1	1	1
3	Poker, or Scraper....	1	1	1
4	Shovels	2	2	1
	Group "C," Tools, Cans, Lamps.			
	Bucket, Ice	1	1	1
1	Bucket, Tank	1	1	1
2	Cans, Combination oil and grease	1	1	1
3	Cans, Valve Oil......	1	1	1
4	Chisel	1	1	1
5	Cup, Drinking	1	1	1
6	Hammer	1	1	1
7	Hook, Packing	1	1	1
8	Iron., Sponging	1	1	1
9	Lamp, Red (or comb. red and white).....	1	1	1
10	Lamp, White. (or comb. red & white)	1	1	1
11	Torches	2	2	1
12	Wrenches, A. P. and Spanner	1	1	1
13	*Wrenches, Alligator.	1	1	1
14	*Wrenches, Grease Cup	1	1	1
15	Wrenches, Monkey ..	1	1	1

*Only when required.

**Shifting Locomotives having two headlights will be supplied, at designated points, with lamps, flags, etc., to carry out train signal rules, when required to go beyond yard limits.

°As standard.

°°Tank ropes and push poles may be omitted from locomotives assigned exclusively to helping service.

With this arrangement the enginemen are required to report on regular daily work sheet the actual condition of tool equipment. The Master Mechanic and Road Foreman should check up against these reports by a periodical inspection made at intervals of not less than once each month, preferably at stated boiler wash periods. On some roads it is the usual practice for enginemen to carry in their personal hand bag, certain small tools, such as small monkey, stillson and "S" wrenches, which must many times well repay for all the trouble that it is to take care of these articles, and the many advantages secured from this kink makes it surprising that the practice is not more general on all railroads.

Another plan about which we have some information, is to equip all locomotives when first placed in service with a full complement of tools, and in order to insure locomotives always being provided with the full equipment, arrangements are made that on the arrival at each and every terminal to make a joint inspection of the tool equipment by the engineman and inspector, and before leaving the terminal an inspection is made by the engineman, and when any of the equipment is found missing or defective, a proper investigation is started with a view of locating responsibility and insuring articles being replaced before locomotive leaves the terminal. This arrangement was found to be unsatisfactory, as the program did not provide for a joint inspection immediately before locomotive left the terminal, thereby permitting the criticism that enginemen could charge the shop with more than their full share of missing material, together with the fact that the expense involved by the inspection made in this manner was excessive and out of all proportion to the saving effected for tools properly chargeable to locomotives.

In conclusion I would emphasize the statement that no method of instructions can be made so perfect in detail as to be automatic. In other words, the results will be effected by the personel of the entire force. Therefore, the most effective supervision will be that where each man becomes more interested in securing efficient service than in making an individual record at the expense of the general efficiency, and to this end I would respectfully invite a free discussion of the several thoughts herein outlined in order to in some degree assist those responsible for the performance of locomotives to formulate methods of supervision that will tend to reduce to a minimum the cost of their operation and maintenance.

PRESIDENT: Gentlemen, this paper is now before you for discussion and there are a number of practical railroad men in the room who are competent to discuss it and bring out a lot of information which will be of value, not only in training enginemen but caring for supplies and equipment, matters concerning which all who have to do with them will agree there is room for very great improvement. I will ask Mr. A. G. Kinyon, Special Instructor of the B., R. & P. Ry., to open the discussion.

MR. A. G. KINYON: Mr. President and members of the Railway Club of Pittsburgh, I hardly expected to be called upon to open this discussion. I feel that there is but little to be said in addition to what Mr. Alexander has said in his paper, and I certainly have enjoyed hearing it and appreciate its value. There are some points in connection with it which I would like to bring up, one being that the modern engine crew have not the opportunity for acquiring information which they formerly had. In this we are afraid we cannot agree with Mr. Alexander. We believe that with the pooling system in vogue, together with the agreements made with the enginemen and firemen of today, that they have much more time for informing themselves in regard to the mechanism which they are handling and the proper methods for handling it that heretofore. The railroad companies themselves are providing better facilities in the way of instruction rooms, books, etc. The manufacturers of equipment are supplying information applying directly to their products which any of the men may acquire. Aside from this the enginemen are not required to do terminal or round house work as much as formerly, neither are the firemen required to do cleaning. This gives them time, if they so desire, to gain additional knowledge.

As to instruction by means of circulars, it is difficult to get men to comply with instructions issued in that form unless it is supplemented by direct personal instruction. One of the largest factors, possibly, of economical locomotive operation is the maintaining of harmony between the two men on the engine. This of course must be supplemented by the same understanding of proper methods on the part of each man. In this connection it devolves upon the road foreman of engines to exercise a great deal of tact, as mentioned in Mr. Alexander's paper, in handling the men and in seeing that the crews on the engines are congenial in order that they may work together and get results.

In connection with the matter of economy in the actual handling of the fuel on the locomotive, we believe that the proper method of carrying the fire is unquestionably that of an even thickness fire. We cannot believe that any economical or better results can be had by carrying a banked fire, even though it be to a small amount. Grate area in the modern locomotive has been increased from 200 to 300% in the past 15 years, and the purpose of this has been to secure a slower rate of combustion per square foot of grate area, and if we cut out part of this added grate area by carrying a bank on part of the surface, it would negate the effort made toward more economical results.

In the matter of swinging the fire door or of leaving it open or not closed completely for purposes of economy, it has been our experience that where the fire door is closed to the latch at least after each shovelful and then after the gases that have been produced in large quantities by the freshly added coal have burned off to some extent, that more economical results will be obtained by closing that door. We believe that the proper place for the air to enter the fire in order that it may supply the proper amount of oxygen and bring this element in direct contact with the fire, which is absolutely necessary for burning, is, that it should come up through the grates to the exclusion of any considerable amount coming through the door. We believe that the modern locomotive is an incentive to poor work on the part of the fireman more than the old type of deep, long fire box. Those of us who fired engines of that type know that it was absolutely essential that we close the door after each shovelful and get it closed as quickly as possible if we were able to keep the engine hot. From the fact that we have a large grate surface in the modern locomotive and easy steaming qualities we find carelessness in regard to these points. I have knowledge of cases where the door is left open while a fire consisting of six or eight shovelfuls is put in. This is certainly bad not only from an economical standpoint but from the standpoint of boiler maintenance. It is impossible to keep flues and staybolts tight if such practices as that are followed. On the B., R. & P. Ry. we believe that the pneumatic fire door openers which allow the door to be closed after each shovelful without any special effort on the part of the fireman, is a fine thing and we are applying them and are satisfied it will prove a good investment.

In the matter of handling the supplies, both oil and fuel as well as general locomotive supplies, it is being watched quite carefully. The Bowser system of tanks and pumps are used and accurate records are kept as to the results of the performance secured. One point that seems to be misunderstood on the part of some enginemen and firemen is the effect of wetting coal. We believe that aside from the wetting of it for the purpose of cleanliness and to give weight to the fine coal so that it may be retained in the fire box long enough to begin to burn at least, wetting of coal is a detriment because the moisture added to the coal in this way must be evaporated before the coal can commence to heat and the elements of which it is made up separated in shape for burning. This of course requires heat.

About two years ago the Mechanical Department of the B., R. & P. Ry. issued an instruction book on the economical use of fuel. The results had from this instruction led somewhat later to the equipping and putting into service of an instruction car along lines which we believe to be a departure from the usual instruction cars.

In this car we instruct the men not only in the proper methods of firing, but give them a thorough understanding of the chemistry of combustion and the "whys" of the different conditions with which they are familiar from practice, but which they are not able to explain to their satisfaction or to the satisfaction of any one else. We have divided the subject into three lectures, with chemical apparatus to illustrate the first one of the three. Carbon and hydrogen are used in connection with pure oxygen and demonstrations made to show under just what conditions they can be burned. In the second lecture a sample of coal is taken and the gases distilled from the sample, allowing the men to bring in samples of coal from the engine. The gases are collected and burned under different conditions, showing the amount of water evaporated under conditions of rapid combustion and also conditions of slow combustion. Also that the gases are volatile matter or hydrocarbons and that it is impossible to use them until they have been heated to a certain temperature. Show them clearly where the black smoke comes from, how it may be prevented and give them some idea of the loss that is represented by the escape of the black smoke and try to impress upon them the necessity of carrying a light, bright fire through which the air can pass without difficulty to supply the oxygen necessary for proper combustion.

In regard to the difficulty of getting men into the instruction cars and afterward getting them to follow instructions, we know that the service on our railroads is such that there can be no stated times at which any particular man can be expected to attend instruction, but if a sufficient length of time is given at the terminals for the different men to get in we believe, and it has been our experience, that an interest may be aroused which will give satisfactory attendance and result in an improvement in the service which more than justifies the expenditure which such service entails. The third lecture given in connection with the stereopticon, shows proper methods of locomotive firing and operation, and are reproductions from our instruction book. We also have in stereopticon slides the Walschert and the Baker-Pilliod valve gears, as well as the Stephenson gear, together with lubricator and injector slides, all of which subjects are taken up from time to time so that the men are given opportunity to inform themselves, and if they do not embrace it there will surely be no one at fault but themselves.

PRESIDENT: I notice Mr. R. L. Evans, Road Foreman of Engines of the Wheeling & Lake Erie R. R. I understand they have some up-to-date methods for taking care of their tool equipment that we would like to hear about.

MR. R. L. EVANS: About four years ago our engines were pooled. We then began to have trouble keeping engines supplied with tools, cans and other equipment.

Our Master Mechanic had a few sets of individual outfits consisting of metal tool box and bucket which held the oil cans, constructed and gave them a trial. They showed a very nice saving on oil and tools. Since then nearly 200 outfits have been put into use.

The tool box is 18½" long, 5" by 5", No. 18 B. W. G. iron.

Engine bucket 13″ in diameter and 13″ high. Large enough to hold engine supply can, valve oil can, grease tube, engine torch and hand oiler. Engineman's name on brass tag soldered on cans, bucket, hand oiler, torch, lanterns and tool box.

Tool box has clasp at each end to securely lock lanterns to box when lid is closed and locked. Tool box to contain 18″ monkey wrench, one smaller monkey wrench, hammer, chisel, nut set, spanner rod cup wrench.

These outfits for enginemen are taken off and placed on the engines by oil house men, without any additional expense.

Oil house men on finding enginemen marked to go out on round house board, with destination, fill cans for round trip, placing them on engine.

All lamps, such as headlights, cab and classification lamp, are filled and cleaned by round house force. This does away with supply engines with headlight and signal oil.

The individual outfits are showing 30 per cent. saving on oil and corresponding saving on cans, lanterns and tools.

PRESIDENT: Mr. W. C. Hayes, Superintendent of Locomotive Operation, of the Erie Railroad, is here. This is one of his hobbies.

MR. W. C. HAYES: I deem it an honor as well as a privilege to be present and to have heard a paper so ably prepared and covering such a wide range as the one presented by Mr. Alexander. My only regret is that the scope of the paper as presented is so great that it is almost impossible to even briefly analyze a portion of the topics presented. Inadvertently the Chairman paid the Speaker a compliment, or at least it is so taken, when he said that locomotive operation is one of my hobbies. That is true. I have made a study of it almost since a child and am just now beginning to learn some things about it. If we were to take up and analyze even one subject at this meeting—the subject of fuel economy alone—which as Mr. Alexander said is one of the largest single items of expense to all railroad companies in the country. With the road with which I am connected it means in the neighborhood of $4,000,000 annually. That subject could be classified under twenty-six different heads and each one furnish a paper that would provide food for discussion that would take up an entire evening. However, I shall try to be as brief as I can and not tire you with details, although it is supposed that is what most of us are looking for at this time.

A few notes were made while Mr. Alexander was reading his paper with reference to the subjects to be discussed. The relative importance of the three points presented is to my mind somewhat at variance with the manner in which it was presented by Mr. Alexander. Oil and stores are large items of expense, but when compared relatively to the fuel account, the ratio is probably fifty or one hundred to one on all the large systems. The lubricating oils on the Erie R. R. costs in the neighborhood of $134,000 annually. The stores at this time required to equip 1,500 locomotives with tools cost in the neighborhood of $93,000 annually. That means about $60.00 per engine. We try to maintain the oil schedule somewhere within the shadow of the guaranty, and all of you gentlemen know what the guaranty means.

The educational features are those that perhaps demand and should receive the greatest attention at this time. Methods of employment are secondary in connection with the educational features involved. To my mind the education of a man for the position of locomotive fireman should begin some considerable time before he enters the service of the company, and it is believed there is a plan at the present time that if taken advantage of will perform that apparently difficult task. I am not the representative nor have I any interest in any correspondence school or educational feature outside of those employed by the company I represent. But a plan has lately been presented by one of the correspondence schools that opens up a field of usefulness to the railroad companies in preparing men for service before they are engaged that will add very materially to the income from a reduction in fuel consumption as soon as one of its students is actually employed as a fireman. That is to have the agents of any railroad company at every station represent the company in the selection of firemen and secure candidates for the correspondence schools, with at least a quasi understanding that all other things being equal they will be given preference in employment, if you please, and proceed to educate them in matters pertaining to locomotive operation with particular reference to the question of fuel economy or methods of firing a locomotive, before entering the service. Possibly many would take exception to a plan of that kind on the ground that a small commission might have to be paid by the correspondence school to the agent and think that this might lead him to increase his salary by getting as many men as he can to fill out blanks for this correspondence school, sacrificing quality for quantity. But to my mind this is a very poor argument against securing a better selection of material than could otherwise be secured for the position. We have on the Delaware Division of the Erie Railroad at least 15 of that class of men who have recently been engaged as firemen and their records have been watched very closely and they have so far demonstrated the virtue of this plan by outstripping in every way, so far as economy in the use of fuel is concerned, men who have been actually engaged in firing a locomotive four or five years, they are the very best firemen we have on that division at this time.

The speaker agrees with the author of the paper exactly that the limit of capacity of a road foreman of engines is at the maximum not over 100 engine crews, and where he has to spread his efforts over a much larger territory, or a greater number of crews, the work can scarcely be performed with the same satisfaction or the same results as would be the case if he had a less number of crews to supervise. When it becomes necessary for one reason or another to assign a road foreman to a large territory or a greater number of crews the work can be supplemented by what we are pleased to term schools of instruction, so that the road foreman of engines can have an opportunity to meet with all of his men at least once or twice a month, appointing certain definite periods for the discussion of different subjects that may be of interest or importance to the operation of the power on any division.

We have found that this scheme works out very well indeed, for the reason it is almost impossible for a road foreman of engines to ride engines every day, and if he did and confined his efforts to riding engines alone, it would be almost impossible for him to ride over 30 to 50 engines a month and then he would have to neglect many of the other details of the manifold duties that devolve upon a road foreman of engines, especially in a large territory.

The speaker is not a very great believer in the idea that a brakeman can be evolved into a successful fireman. It is usually the other way, the fireman gravitates into a successful brakeman, because the fireman thinks the brakeman has an easier job, and a great many people on earth are looking for the easiest side of it and the fireman is no exception to that rule. So that the old plan that was in vogue a number of years ago of promoting brakemen to the position of fireman with a view of having them well trained in operating duties before reaching the position of fireman, having a thorough knowledge of signals and a smattering of the train rules and practical operation that might help him enormously in handling the duties of a fireman, have long since been swept away by the introduction of the heavier power and the larger and heavier trains, involving, perhaps, and I say that advisedly, very much greater effort on the part of the fireman of today than was required years ago in the actual firing of the locomotive. Our practice today in the hiring of firemen is to hire everybody mostly that comes along that presents the physical characteristics and can pass the necessary physical examination. It is necessary for us to do that at times in order to keep our trains moving. A fireman, when he first starts in, begins as a student, usually is sent out with a fireman that knows about as much about firing as he does himself, and to me it has always looked a good deal like the blind leading the blind. He rides a sufficient number of trips in each class of service until he can secure the signature of a certain number of engineers who will say that he is qualified to fire a locomotive, before he is assigned to duty under pay. By one process or another these men are usually able to secure the signatures of the engineers when they know very little about firing. We then undertake by a system of what we call progressive examinations of engineers and firemen to post the firemen in their duties, and for that purpose have a number of questions in printed form that are given to the men in the first and second years' service, and so on until the third year has been served, and then a book of questions covering a mechanical examination is given to the candidate to fill out upon which he may be examined, and after a certain percentage has been reached he is promoted to the grade of engineer.

So far as the question of tools and other supplies are concerned, we have a system of checking tools on and off engines, both on arrival and on departing from terminals, that practically precludes the possibility of the loss of tools other than those that may be destroyed by use or breakage. A list of the tools checked on the engine is presented to the engineer, which he signs, and a stub is returned to the departing terminal and he presents the list at the arriving terminal, and that is again checked at the arriving terminal to see whether or not the supplies he left the departing terminal with are on the engine upon arrival. With this system installed we have been able to make a material saving in tools and other supplies furnished to locomotives and expect in the near future to be able to report economies that will perhaps be astonishing when compared with the high cost several years ago.

We also have worked out and have in successful operation what is known as an engineer's individual performance sheet, which gives a record of the cost of coal, oil and stores used for each individual engineer, in passenger, switch, pusher and helper and switching service. It is worked out on the ton and locomotive mile basis, crediting the cost of tools, oil and fuel to the individual. We have a column for percentages which shows the standing of the individual engineer on each of the three items over which he exercises control. We expect with some degree of confidence that after we have that plan working for a year we will be able to show some considerable economies resulting from the introduction of this individual performance sheet. It represents a lot of work, but we think it will pay in the end.

I do not know of anything else that I have to offer on the subject. I thank you very much indeed for allowing me to appear before you and I appreciate the privilege of being here.

PRESIDENT: Mr. S. D. Nutting, Road Foreman of Engines, of the Bessemer & Lake Erie R. R., is here and we would like to hear from him.

MR. S. D. NUTTING: Mr. President and gentlemen, I did not come here prepared to make any talk; I came to listen to the paper of Mr. Alexander and get what information I could from the discussion it would bring out.

In the handling of these supplies on our road we have experienced quite a good deal of difficulty, but we now have a system that is quite satisfactory, but still open for improvement. I thank you for the privilege of being here.

MR. JULIUS KRAUSE: Mr. President, I wish to say that I enjoyed Mr. J. R. Alexander's paper and its discussion. It shows that the men in charge are working along the proper lines. I am unable to agree to the point brought out that the engineers of today do not require as much knowledge as the engineers of long ago. While I admit that my ability to run an engine is small, although when I started to ride on engines, 40 years ago, we had different conditions. We knew nothing about double-headers, no automatic couplers, but used link and pins, no air brakes, no train signal, no steam heat, no electric lights and no block signals.

The locomotives forty years ago were small and the cars they were required to haul were light and fewer in number and very little fear experienced on account of rear-end collisions, as trains were few. Passenger train schedules were slow. At one time trains stopped at Latrobe for meals, but times have changed. Climb into a cab of a modern locomotive and the boiler extends above your head and front of boiler is covered with various sizes of pipes and the fire-box has grown to a great size, also flues have grown in number. One of the cars they are hauling weighs as much as five cars weighed 40 years ago. We now come to the speed of 60 miles per hour, which is not considered fast. Therefore, I claim the modern engineer and fireman of today must understand how to perform their duty; if they fail they must explain the next day.

I thank you.

MR. C. A. RICHARDSON: Mr. President, a few meetings previous to this Mr. L. H. Turner, Superintendent of Motive Power, of the Pittsburgh & Lake Erie R. R., read a paper on "Practical Education for Railroad Service." At the time the speaker made a few remarks upon the subject, but I have thought many times since that I did not quite understand the idea which

Mr. Turner wished to convey, and from reading remarks made by others, I am inclined to think they did not either. However, I am satisfied that if Mr. Alexander had been present upon the occasion when the paper was read, he would have more readily grasped the idea intended, and give us a practical exemplification of what is desired in railroad service. I should so judge this from the manner by which he has acquitted himself tonight.

Now, Mr. President, from the paper and remarks that have followed, I would naturally infer that the locomotive, its operation, and those who operate it, i. e., the enginemen, are very important factors so far as the dividend end of railroad operation is concerned. I feel very much elevated over the way those present have talked and feel somewhat proud of the fact that I am an engineman. I also realize to some extent the responsibility which rests upon me in that capacity towards my employer. I have been connected with the locomotive a good many years, but for all that I find that there is always something new for me to learn. Now I very much approve of the position of those who have preceded me that the engineman must be educated, both theoretically and practically, in order to give good results. The better informed that we are of the machine that we have to handle, the more confident we are of ourselves, and the better fitted we are for the responsible position which we hold.

Now the trend of Mr. Alexander's thoughts which he has given to us in his valuable paper is that economy, not only in the consumption of fuel, but also of oil, is a very important factor in the railway service from a financial standpoint. A little thought suggests itself to me that such ideas as Mr. Alexander has suggested practically adopted, from the economical standpoint, would encourage the all-important subject which is agitating some of the minds of our statesmen—that of conservation of our country's resources. Practically carried out, our supplies of coal and oil which is taken out of Mother Earth would last much longer. Mr. Alexander speaks quite extensively on the course of instructions which enginemen and firemen should receive. First: The fireman as to his duties principally in the proper firing of a locomotive in order to get the best results. Now I was a fireman at one time, and while it was a great many years ago, still I have not forgotten my start in that position. It was on the old Atlantic

& Great Western Railroad, a part of the system which my friend, Mr. Hayes, now has charge of. I happened to be placed on an engine with an engineer whom I have very often thought was not inclined to take very much interest in the fireman. I feel that such is not a proper disposition for an engineer to show, because I believe that it is our duty to build each other up as far as our experience from practical knowledge will permit us. The engineer has the benefit, providing he has been such, for a number of years of the methods of the different ways applied by the firemen in firing engines, and hence is in a position to learn from experience from these men which is the most satisfactory way to fire a locomotive in order to get good results.

From what I have learned I would say that the lighter a locomotive can be fired the results will be more satisfactory than if the firing is done heavily; the fire will be cleaner, hence drafts to the fire-box will be better, and very much of the nuisance from an unnecessary amount of black smoke will be minimized. I presume, however, that our instructors of firemen, and as well our Road Foreman of Engines, do not receive very much encouragement from firemen, as a rule, when these instructions are given them.

Mr. Alexander speaks of the proper equipment of the locomotive in the matter of tools, oil cans, etc. The time was, I may say it was a good many years ago, when engineers felt that they would be leaving their terminals before they were ready if their engine was not equipped with a saw, ax, a lot of blocks, chains, hammers, wrenches, chisels, etc. At the present time the most, and I may say the only essential tools, which are necessary are a large monkey wrench, a smaller one, a good hammer, good chisel and a Stillson wrench. If he has these tools at his command, it is about all he will need to go over the road.

Mr. Alexander has given us a practical paper, and I have enjoyed listening to him reading it very much.

I thank you gentlemen for your kind attention.

PRESIDENT: Mr. Elmer, Master Mechanic, of the Pennsylvania R. R., is here. May we hear from him?

MR. WILLIAM ELMER: I will only attempt to say a word on one sentence where Mr. Alexander refers to the necessity of supervision and care at certain stated intervals. He names the boiler wash period. I might say that we have prepared a little list of some of the operations we think desirable at boiler wash period, and for the benefit of our friends that have been in the same boat I will run over two or three of the more important things that we have found it desirable to do at this time. The sponging of the driving boxes and engine truck boxes should be examined to see whether they are in proper condition; do not wait until the boxes run hot. The tender truck and trailer truck also, in case the engine has a trailer. It may be practical to wash out the tender cistern and see that all the accumulations of mud and stuff that gets into the cistern is cleaned out so that the injectors will perform their duty without stopping. And see that the tank strainer is in good condition. We take that opportunity to pack the injector starting valves, gauge cocks, glass water-bottle and all the valves in the cab that have been detected as leaking. We have also found it desirable to give to the engine a special air brake test. Engines allowed to run month after month develop leaks in the various connections and in the cylinders, and we actually put the gauges on to see what the leakage is per minute. If it passes a certain limit the repairs are made at that time and the engine is good for another month. We also take the couplers apart to see that the locks and the knuckle, the wearing parts, knuckle pins, etc., are not worn to a certain gauge limit. We also gauge the pilot and see that it is not below the limit of clearance. Also draw the water out of the main reservoir and have recently been taking down the valves and taking out the piston in order to examine the condition of the valves and valve seats, the cylinder packing and the piston rod at the cross head.

Perhaps some of the trouble we have had in the past we are going to cure by this method of actually getting the engine apart and looking at it to see what condition it is in.

PRESIDENT: Mr. H. B. Brown, Master Mechanic, of the Erie R. R., is here and we would like to have him say a few words.

MR. H. B. BROWN: Mr. President and gentlemen, my superior officer, the Superintendent of Locomotive Operation, has covered the ground very thoroughly and there is not much to be said.

I would like to mention, however, that we have a number of forms with reference to the remarks Mr. Hayes made and we would like to exchange with any of the gentlemen who have similar forms. I will leave them with the President.

(The speaker here described the forms.)

MR. ELMER: How will we get them if we do not have any to exchange?

MR. BROWN: We are willing to give to those who make application for them. It would be interesting to go over these forms in detail, but it is so late. It is something Mr. Hayes and some of us have worked over for years.

PRESIDENT: This information appears to be very valuable, and I think many of us will take advantage of Mr. Brown's offer.

As it is growing late I will ask Mr. Alexander to reply to any question which may have come up or which he may want to explain further.

MR. ALEXANDER: I hardly see that there is much to reply to in the various criticisms. The friend from the Buffalo, Rochester & Pittsburgh R. R. must not understand me to say that I think railroads generally are not now making an effort to give their men opportunity to learn what is necessary, but I do think that forty years ago or less, as stated by our friend, Mr. Krause, it was true what had to be known the men learned by actually doing the work, as was possible working under the assigned arrangement. Later on, after the system of handling engines had been changed to the pooling arangement, we forgot all about the men not having the same opportunity, and things drifted along fairly satisfactory for a number of years by reason of the men grown up under the old system knowing all about locomotive machinery, but all at once we awoke to the fact that the young men coming into the service did not know much about machinery, largely because having no direct responsibility for the keep-up of the engine, which gave them too much idle time on their own hands, none of which was taken up with self-education. Most roads for some time have been making earnest efforts to catch up and give the men necessary instructions and facilities for self-education. The man handling one of the modern locomotives has got to know just what he will do under all circumstances before the emergency arises, as ninety-nine times out of a hundred he would otherwise not do the right thing when the emergency actually occurs, as under the conditions of road service he has no time to turn over in his mind and reason out what to do. Did you ever notice that on a busy run how difficult it is to hear one another talk, and a good many times the necessary conversation must be done in pantomime.

I am a strong advocate of the level fire method, but it is a fact that with the increase in grate area to 55 or more square feet in the modern locomotive, it is beyond the physical ability of the fireman to maintain a good even thickness of fire, mile in and mile out, when they could do so where the grate area was considerably less. This, no doubt, is the explanation why some firemen secure the best results with a portion of the grate bricked off.

There must be a happy medium between extremes as to when the fire door should be slightly open or closed. However, with a (good) fire it is my thought the closed door and all the air coming through the fire will increase the gas-producing properties of the furnace without furnishing the other required elements for completing combustion, although under certain conditions the excess air coming through the fire will become so high in temperature as to result in a more perfect combustion.

Another phase of the question not to be included, is that keeping the door ajar, together with good firing, is the most effective means at hand to overcome the so-called smoke nuisance. Even for this purpose it is sometimes used to the detriment of boiler and maintenance.

I understand the various designs of pneumatic fire doors considers it essential to admit air over the fire and to do so through registers in the door or its ring casting.

The methods they have adopted on the B., R. & P. R. R. of instructing men is no doubt in advance of what some of the rest of us are doing, and for myself it has been interesting to listen to the remarks made on this phase of the subject.

Mr. Hayes, of the Erie R. R., says the interest of fuel economy is measured by dollars and cents, and is of greater importance than the matter of lubrication. I do not know but there is more trouble and worry to the men on the road from the oil situation which requires equal supervision to that of the fuel account in order to obtain economical results with either. There is frequently more big noise made about a little oil spilled than there is for a whole tank of coal upset. It is the efficiency record that requires attention, it making no difference to us what either costs or what the item is, the Road Foreman should strive to attain 100% along all of these different lines. They have some elegant facilities on the Erie R. R. for following these matters up, and quite a little can be learned by making inquiries as to how things are being done on the Erie road.

It is altogether right to encourage higher education of any man, the practical railroad man not excepted, yet if it was up to me to get results I would much prefer having locomotives of good design operated by men of average intelligence and education,.who would be governed by certain definite and practical instructions edited on the "do" and "do not" order, over any extensive system of elaborate technical education.

In regard to brakemen not making desirable firemen, that is a thought that I believe will bear considerable study, but there are not many of our large roads that could get trains over the road today without the brakeman. On the line I represent there are probably 200 new firemen on the road between Pittsburgh and Philadelphia during this present month. Where they go out on the large locomotive with but little experience they frequently have difficulty to maintain full steam pressure, and should the brakeman not come up willingly and help out, there would many times be locomotive failures. With the proposed scheme it is up to the employing officer to put the man where he is best suited, and it must not be thought that all brakemen are going to be firemen; there will still be just as many of each as at the present time, but when a man comes for employment that is the time he would be willing to agree to anything to secure the job, after which it would be up to them to use him to the best interests of the service. As it is now, when he works at a job doing nothing harder than riding in the cabin, you can hardly blame him for not wanting to take up the hard work connected with firing our large locomotives.

I would concur with most of the remarks made by the gentleman on the right side of the house about tool equipment, except about the Stillson wrench. It is a great mistake to put a Stillson wrench on a locomotive. There are more than a few round-cornered nuts on the locomotive from its use. There is one railroad or division that I know of having 345 engines that has not put a Stillson wrench on any of them for the past two years. These engines go into an engine house at one end of their run, where they also take care of other division locomotives that do have the Stillson wrench, and you can pick out the engines belonging to their division by the results of the use of a Stillson wrench. The use of wrong kinds of tools by engine crews is a matter largely up to the Road Foreman of Engines, and is one worthy of careful investigation.

MR. C. A. LINDSTROM: While I am not engaged in railroad service at present, and Mr. Alexander's paper treats mainly on locomotive firing and taking care of locomotives, it contains a number of very valuable points, such as the employment of men, the teaching of men and bringing them up to the position and fit them to occupy them, and I think we can all study that profitably. Therefore, I hope you will all rise and give a vote of thanks to Mr. Alexander for his very valuable and instructive paper.

The motion was seconded and carried unanimously.

ON MOTION, Adjourned.

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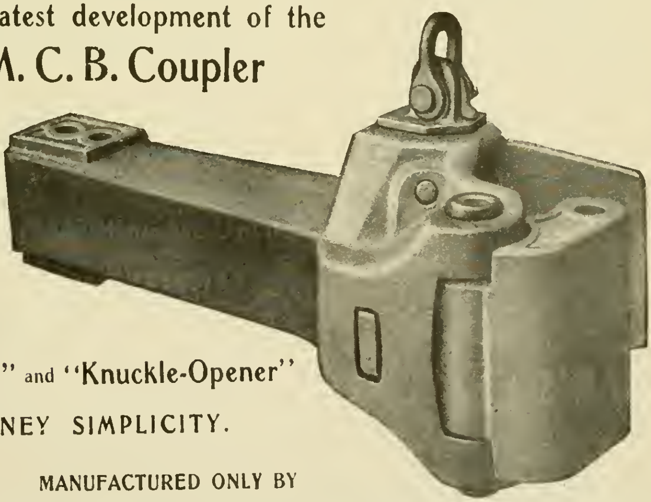

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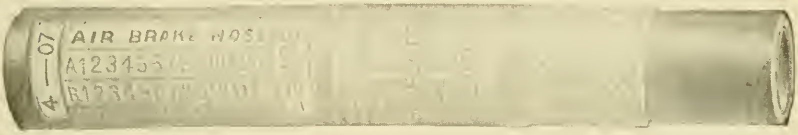

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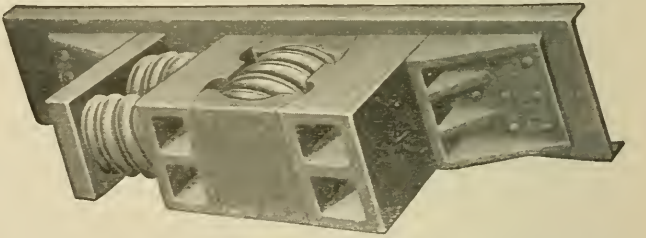

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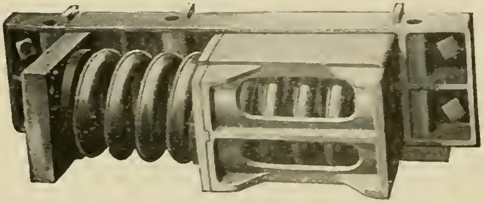

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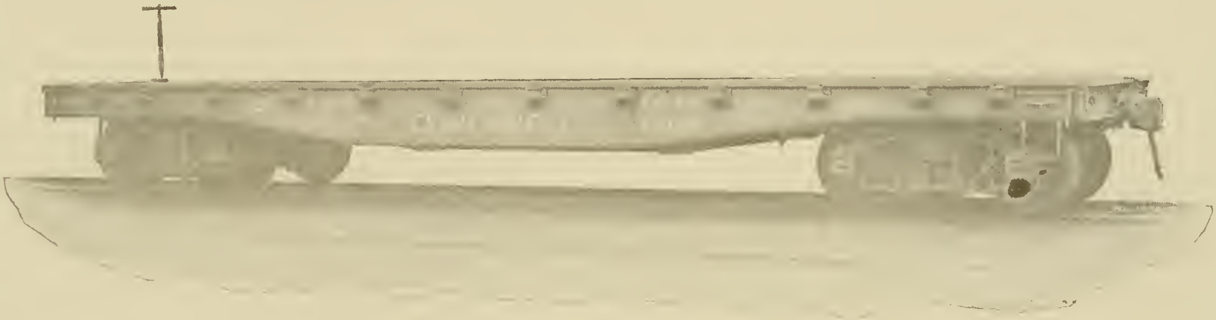

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* This is the fourth in a series of announcements regarding the "Testimony From the Actual Users." Others have appeared in previous issues and will appear in later issues of this magazine.

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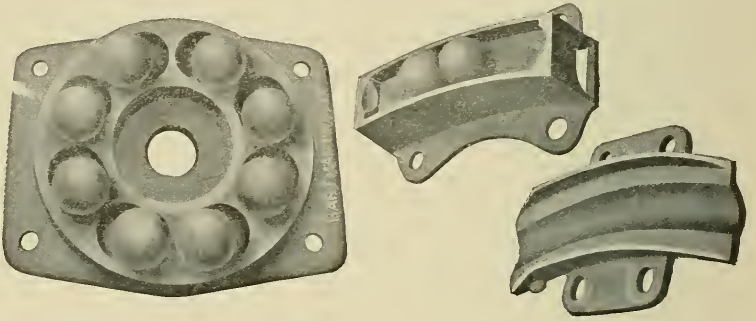

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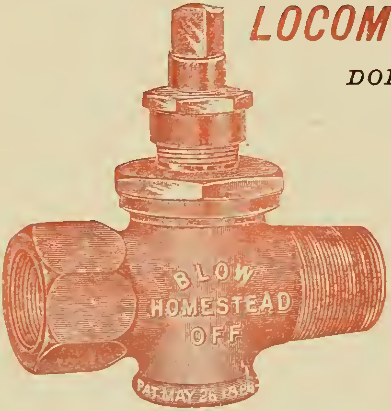

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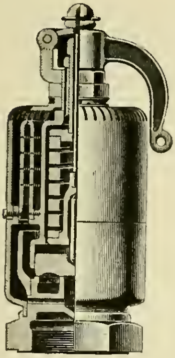

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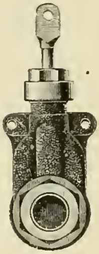

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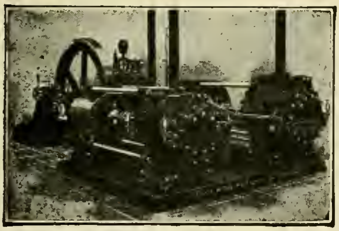

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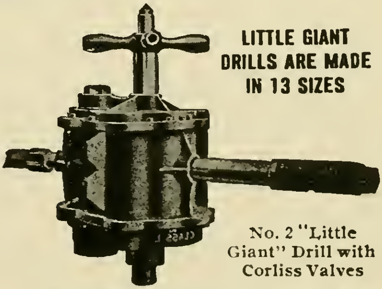

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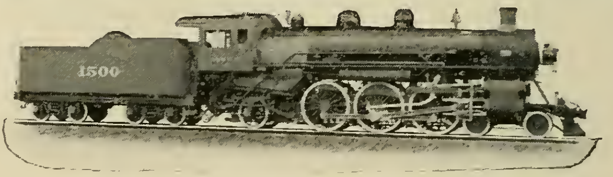

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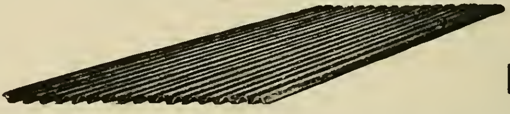

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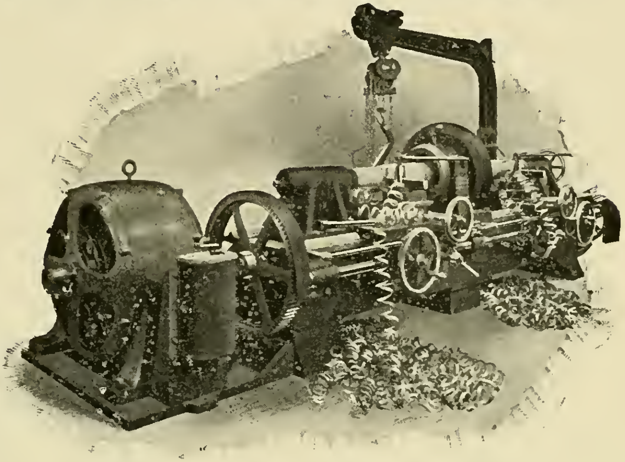

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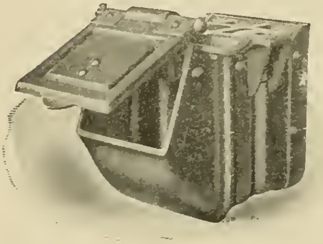

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VOL. IX.
No. 4.
Pittsburgh, Pa., February 25, 1910.
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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING,
FEBRUARY 25th, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock p. m., with President D. J. Redding in the chair.

The following gentlemen registered:

MEMBERS.

Alleman, C. W.
Amsbary, D. H.
Barth, John W.
Bealor, B. G.
Beltz, John D.
Bishop, J. B.
Boyer, Chas. E.
Brand, Thos.
Brownscombe, G. J.
Chapin, E. S., Jr.
Chittenden, A. D.
Colburn, Wm. W.
Conway, J. D.
Coulter, A. F.
Criswell, A. B.
Crouch, A. W.
Cunningham, Robert I.
Delaplane, J. L.
Dette, R. E.
Dickinson, F. W.
Duff, Samuel E.
Elmer, Wm.
Foller, Chas. S.
Foreman, J. E.
Fullerton, A. W.
Gallinger, Geo. A.
Gearhart, J. A.
George, Miles E.
Gilg, Henry F.
Good, H. J.
Gutierrez, S. J.
Haas, Benjamin
Hackenburg, J. H.
Hood, D. G.
Howe, W. C.
Huyett, E. G.
Imhoff, H. B.
Kaup, H. E.
Kennedy, Jas.
Keyser, R. H.
Kinter, D. H.
Kissinger, C. F.
Knickerbocker, A. C.
Knight, E. A.
Koch, Felix
Koch, H. J.
Krause, Julius
Krepps, W. K.
Kull, W. A.
Lobez, P. L.
Long, R. M.
Lynn, Samuel
Mackenzie, R. H.
Mason, Stephen C.
Mercur, H. T.
Metcalf, H. E.
Miller, F. L.
Milliken, I. H.
Mitchell, A. G.
McCaslin, A. W.
McFeatters, F. R.
McGregor, J. E.
McIlwain, J. D.
McInturff, C. A.
McKee, D. L.
McKeen, J. W.
McNulty, F. M.
Oates, Geo. M.
O'Connor, Chas.
Oliver, W. H.
Orchard, Chas.
Pitzer, Edwin H.
Porter, H. V.
Proven, John
Quest, W. O.
Rea, C. S.
Redding, D. J.
Richardson, C. A.
Richardson, W. P.
Riley, J. W.
Rinehart, H. W.
Robbins, F. S.
Robinson, S. R.
Rupp, R. D.
Ryan, W. F.
Sager, Wm. B.
Sanderson, M. W.
Sattley, E. C.

Scheck, H. G.
Schlacks, W. J.
Schultz, Geo. H.
Shuck, Wm. C.
Smith, A. D.
Smith, M. A.
Smith, W.
Stafford, Samuel G.
Stark, F. H.
Sweeley, G. P.
Symington, C. J.
Tamkins, B. L.
Thompson, B. E.
Turner, L. H.
Warfield, J. M.
Warnock, H. R.
Weigel, F. S.
White, Jas. D.
Whited, Willis.
Williams, W. W.
Wood, Ralph C.
Woodworth, R. B.
Yohe, J. B.

VISITORS.

Archibald, Frank B.
Beatty, E. A.
Bibbins, J. R.
Borland, W. P.
Calihan, Earl B.
Conlon, P. J.
Cross, C. W.
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Damon, Geo. A.
Dravo, M. S.
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Gray, W. C.
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Kinsell, W. L.
Kline, Geo. B.
Kneeland, E.
Knoeppel, C. E.
Krider, H. C.
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Satler, Chas. E.
Shaw, L. P.
Smith, John B.
Smith, Sion B.
Smith, Wm.
Smoot, W. D.
Stoddart, W. G.
Swigart, W. R.
Thomas, I. B.
Thomas, J. H.
Voigt, A. J.
Warfel, J. A.
White, Geo. F.
Wright, L. S.

The reading of the minutes of the last meeting was dispensed with, they being in the hands of the printer.

The Secretary read the following list of applications for membership:

Bannister, E. J., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by James D. White.

Chilcoat, H. E., Rep., Westinghouse Air Brake Co., Westinghouse Building, Pittsburgh, Pa. Proposed by D. J. Redding.

Drake, W. C., Clerk, Office General Superintendent, B. & O. R. R., Pittsburgh, Pa. Proposed by Wm. F. Ryan.

Dravo, M. S., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by James D. White.

Elliott, M. W., Manager, Consumers Oil Co., 1016 Congress St., North Side, Pittsburgh, Pa. Proposed by F. M. McNulty.

Emery, C. W., Yard Master, Monongahela Connecting R. R., Second Ave., near Bates St., Pittsburgh, Pa. Proposed by James Kennedy.

Eissler, Robert F., care Duquesne Steel Foundry Co., Coraopolis, Pa. Proposed by Samuel G. Stafford.

Griffey, J. W., Assistant Train Master, B. & O. R. R., 420 Mansion St., Pittsburgh, Pa. Proposed by C. A. Richardson.

Kinyon, A. G., Special Instructor, B., R. & P. Ry., DuBois, Pa. Proposed by C. W. Alleman.

Kleinhans, H., Manager, Atlantic Equipment Co., 2101 Beaver Ave., North Side, Pittsburgh, Pa. Proposed by D. J. Redding.

Mills, E. R., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburgh, Pa. Proposed by James D. White.

Smith, Andrew D., Jr., Salesman, Crucible Steel Co. of America, Frick Building, Pittsburg, Pa. Proposed by James D. White.

Swigart, W. R., Clerk, M. of W. Dept., Monongahela Connecting R. R., Second Ave., near Bates St., Pittsburgh, Pa. Proposed by P. L. Cox.

Thomas, J. H., Motive Power Inspector, P. R. R. Co., Twenty-eighth St. Shops, Pittsburgh, Pa. Proposed by H. W. Rinehart.

Trout, W. L., Engine House Foreman, Pennsylvania R. R. Co., 619 W. Main St., Monongahela, Pa. Proposed by H. G. Scheck.

Warfel, J. A., Sales Engineer, Linde Air Products Co., Farmers Bank Building, Pittsburgh, Pa. Proposed by A. W. Crouch.

Way, L. A., Superintendent, Duquesne Steel Foundry Co., Coraopolis, Pa. Proposed by A. D. Smith.

Wooding, Manuel, Superintendent, Verona Tool Works, Verona, Pa. Proposed by Samuel G. Stafford.

PRESIDENT: These names will be submitted to the Executive Committee and upon their approval the gentlemen will become members.

The Secretary announced the death of one of the members, Mr. E. J. Randall, Engineer, Maintenance of Way, of the Union Railroad, Port Perry, Pa., who died February 11, 1910, whereupon the President appointed as a committee to draft suitable memorial resolutions, Messrs. F. R. McFeatters, Superintendent, Union R. R. Co.; Edwin F. Wendt, Assistant Engineer, P. & L. E. R. R., and R. A. Clark, President, Interlocking Nut and Bolt Co.

PRESIDENT: If there is no further business, we come to the paper of the evening, by Mr. Harrington Emerson. One of the greatest problems before all concerns which have to deal with manufacturing or other interests which entail labor, is that of the proper method for providing for the payment of labor and the checking of its output. Mr. Emerson, who is perhaps a pioneer in handling this particular line of work, has consented to come here and give us an outline of his method.

THE FUNDAMENTAL PRINCIPLES OF EFFICIENCY.

(Their application inevitably results in improved operation and maintenance and minimum costs.)

BY MR. HARRINGTON EMERSON, NEW YORK CITY.

There are fundamental truths governing the universe. These truths existed before humanity began.

The properties of steam were true a million years ago, and also the properties of iron alloys, and of combustion and of gravitation.

The emotions of men are not radically different in one age from what they were in another. The modern Wall Street speculator in cotton or wheat fully understands and sympathizes with the way Joseph ran a corner on food supply in Egypt nearly 3.500 years ago.

Efficient railroad operation rests largely on rational use of our knowledge of the action of materials when subjected to heat, combustion, gravitation, on rational use of our knowledge of the emotions of men.

In the course of time, there comes some human genius who, by accident of observation, or by the gift of imagination discovers some of these facts, or relation of facts to other facts, a genius, for instance, like Columbus, or Stephenson, or Faraday and these men open up new worlds.

Later comes some other human genius, the practical man, who renders of value the discovery made, a Lord Clive or old Commodore Vanderbilt, who founds an empire.

Still later there is the genius who aggregates and expands, as President Jefferson, to whom, more than any other man, we owe the magnitude and glory of the United States, or as Harriman and Westinghouse.

Finally there comes the fourth stage, that of doing in the best possible manner as to time, place and cost, what has to be done, and here again are many workers.

Some things were done well centuries ago, and not only has no further advance been made, but there has been retrogression. We do not, for instance, have the high ideals of life and citizenship which were not only enunciated but lived up to in Athens 2300 years ago.

In the funeral oration for the Athenians who fell in battle, Pericles said:

"We aim at a life beautiful without extravagance, contemplative without unmanliness. Wealth is in our eyes a possession not for ostentation but for reasonable use, and it is not the acknowledgement of poverty that we think disgraceful, but the want of endeavor to avoid it."

Americans as a nation do not have these aims, but in many matters, especially mechanical rather than philosophical, moral or æsthetical, we have pushed perfection far beyond the dreams of even a generation ago. Especially in railroad building and operation we lead the world in many respects, and particularly can we be proud of such a railroad genius as James J. Hill, who alone of all Americans built a transcontinental line without subsidy, who aggregated and expanded, and, what is exceedingly rare, operated from the first with high efficiency.

It is of "efficiency" in railroad operation that I wish to speak tonight, and I define "efficiency" as attaining standards of time, place and cost.

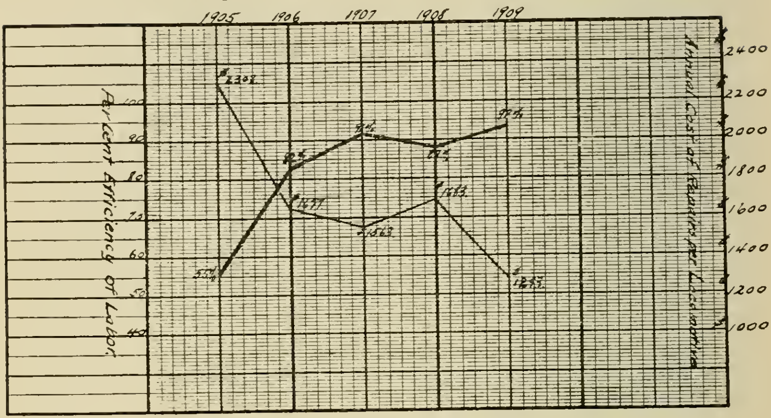
In spots there is very high efficiency in the operation and maintenance of American railroads, but the easily determined wastes due to preventable inefficiency still aggregate one million dollars a day; wastes that would as inevitably disappear, if properly attacked, as the inequalities revealed by a railroad survey disappear when the cuts and fills are finished for any predetermined grade and curvature.

It costs to build a railroad with low grades and mild curves, but as a rule it not only does not cost to attain high efficiency, but high efficiency of operation and maintenance, since high efficiency means the elimination of waste, always resulting in lessened costs.

Costs, operation, difficulties take care of themselves the moment we forget all about them, and substitute the one ideal of "efficiency."

The practical results of substituting the ideal of efficiency for worry about costs is shown in the following diagram, in which the efficiency of labor, in the same shops, with the same men, the same equipment, the same foremen, and on the same schedules was gradually increased from 55% to 93%, the cost of locomotive repairs dropping over $1,000 each, yet the locomotives averaged heavier, hauled more tons and made more miles per failure. If this road had 2,000 locomotives the direct saving was over $2,000,000, but in addition each locomotive hauled 3,300,000 more tons

Efficiency of Labor and Cost of Locomotive Repairs.



Average wgt. of locos	75.63	79.50	81.74	82.98	82.98
Mileage per loco. failure	3160.	4900.	4250.	4641.	6200.
Tonnage hauled per loco. mi.	685.	725.	765.	770.	796.

and in one year the net earnings increased $3,000 per locomotive, an additional gain of nearly $6,000,000, mainly due to the ability to haul more freight.

One railroad in the United States maintains its freight cars for $37 per annum. Another railroad in similar service spends over $100.

The $37 cars cost $100 less to build, weigh 6,000 lbs. less for the same capacity. At $37 on 50,000 cars there is an annual saving of $3,150,000 in maintenance cost alone below the rival figures.

Efficiency principles or laws, like any other branch of applied knowledge, has its own laws. These laws are absolute. You cannot have high and continuous efficiency if any one of these laws is neglected; you can have the same efficiency, and perhaps locally very high efficiency if any one of them is even partially observed, but wherever there is high efficiency it will inevitably be found that it is attained by observance of one or more or all of these laws.

These laws are eight in number:

(1.) There must be "Commonsense."

We railroad men know that elementary commonsense is flagrantly outraged daily in railroad operations.

(2.) There must be "Discipline."

That discipline is lacking has been the official complaint of many railroad presidents.

(3.) There must be the "Fair Deal."

This has been often flagrantly lacking in the relations between employer and employee and between corporation and client.

(4.) There must be "Adequate and Reliable Records."

You give the locomotive engineer a time-table, a watch, a pressure gauge and a water-glass. Is there any common-sense or discipline or "fair deal" in giving the shopman neither schedule, nor watch, nor any other record gauge?

(5.) There must be "Standardized Conditions."

You give the locomotive engineer both a locomotive and a clear track; you give him water tanks and coal chutes; you give him a set of signals. You rely far more on the conditions than you do on the man. The Pennsylvania Railroad has more engineers than it has engines capable of pulling the 18-hour train. When conditions are standardized it is not difficult to find men.

(6.) There must be "Standardized Operation," worked to a schedule, or time table.

(7.) Every worker, from president down, ought to be compensated, partly at least, on the basis of his efficiency.

Standardize the wages for different kind of work—that is right. Standardize the minimum equivalent for the wages. That is both discipline and the fair deal, but, then, pay the better man for his higher efficiency.

The objection to piece work is that it is generally put in before the previous steps have been taken—1 to 6—and it is necessarily wrong in detail and in the long run inoperative.

(8.) Staff men should be put in charge of efficiency work.

A comptroller or general auditor, whose standards are often prescribed by foreign authorities, is in charge of all accounting work. The legal counsel of the road, often a vice-president, is in charge of all legal matters, and similarly all efficiency methods should be prepared and be followed up by staff specialists.

When I am given the privilege of examining the organization and operation of a large plant, it is not the details that interest me. The men about the plant are far more competent than I am to give an opinion as to details. I look for evidences of lack of common-sense, for lack of discipline, for unfair conditions, for inadequate records, for unstandardized conditions, for unstandardized operations, and I base my estimate of preventable wastes on the observance of principles, not of details.

It is not the system, the particular form of blank, that counts. It is the ideal behind any and all system that counts.

A great chess player can win twelve games at once, playing in his mind alone, without either board or men. A board inlaid with mother-of-pearl, men carved out of ivory and ebony and encrusted with precious stones, and all the chess manuals in the world will not help the man who has not actually played the game with a master for teacher in practical operation.

I am more afraid of the gun pointed at me by the man who does not know it is loaded than I am of the footpad's gun. We can be on our guard against criminality, but we are never safe with those who do not know.

A few months ago a trusted official of a railroad turned out to be an embezzler of some $623,000 of good money. Losses of this kind cause marvel because they are rare, because we are on our guard against them. Men in positions of responsibility are bonded, their accounts are checked, complicated systems of accounting are evolved to verify honesty day by day and uncover dishonesty. For over a thousand years methods of bookkeeping have been perfected, until there is a science of accounting, of double entry, which makes it possible for even such expenditures as $500,000,000 a year to be checked up to the last cent. Because of this science of accounting, money and money expenditures are relatively magnified in importance. A paper of pins cannot be purchased without a requisition and a voucher.

All this is well enough, but other stupendous wastes that are not part of the bookkeeping scheme go on unchecked and unknown. The railroads of the United States are wasting one million dollars a day. Checking up the money spent without proper equivalent on one single railroad system, we found it to be $23,000,000 in four years, about $6,000,000 a year, or ten times as much every year as this defalcation in ten years of $600,000, which has aroused everybody.

The methods used to determine losses are so positive, so absolute, so indisputable and so simple, that any competent committee of qualified experts could verify the conclusions, and the name of any one of fifty railroads could be drawn by lot and a similar investigation would show that it was contributing its quota to the loss of one million dollars a day.

Do not imagine that I, an outsider, am slandering a great business of which I know nothing. I have been intimately associated with railroad planning and maintenance for nearly thirty years. I also have learned intimately about other businesses, and the losses complained of are universal and inevitable under our present methods of inadequate check.

Railroad management is not worse than the average; it is, on the contrary, in many respects better. The railroads of the United States, as to special operations, set up and realize as high standards as the world has ever seen. The 18-hour trains between New York and Chicago, the fastest and longest run high speed trains in the world, maintain a standard of promptness of 99.96 per cent. A man living on the line could set his clock by these trains. Here is a case of:

(a) Reliable records.
(b) Standardized conditions.
(c) Standardized performance.
(d) Continuously attained.

In the accounting department standards are equally high. Not a cent is spent untraced, or without authority. Here also:

(a) There are abundant records.
(b) Standard methods of bookkeeping.
(c) Specialized for the operation.
(d) Balances have to be made.

The whole auditing and accounting is in the hands of specialists who take their inspiration not from the Board of Directors, not from the executive officers, but from standards that are not only older than railroading, but which antedate the discovery of America.

Standardized conditions in railroad operation have already been referred to. Among the most important of these are track and way. No higher standards are conceived, created and maintained than the track, way and bridges of a first-class American road. Here again there are:

(a) Records, not always adequate.
(b) Standards of construction.
(c) Standard realization.
(d) The work being conceived and put into effect by specialists, engineers.

Enough to show that in these respects and many others American railroads set up and realize high standards, and to justify what I am about to say as to absence in much of railroad operation of

(a) Adequate and reliable records.
(b) Standardized conditions.
(c) Standards of performance.
(d) Definite responsibility and reward.
(e) Competent specialists.

Usually the man who best executes is not always the best man to create proper conditions, and the best creator is not always the best doer. A locomotive engineer, even though he takes the 18-hour train over his division in perfect manner every day, neither created the track, the locomotive, the dispatching or the signal system, but, on the other hand, the inventors and improvers of these matters were never fitted for locomotive engineers. Let it not therefore be supposed that I am in any way criticizing the great operating contingent in American railroads. They do what they can, and no higher body of men exists. My criticism of results is based, not on the inefficiency of the men, but on the

(a) Inadequate records.
(b) Inadequate and inferior conditions.
(c) Inadequate special skill.

To illustrate what I mean: There is no railroad East of the Rocky Mountains in which locomotives ought not to be maintained in first-class operating condition for five cents per locomotive mile. I go further, and believe four cents is an ideal to be striven for and ultimately reached. This does not mean that if a railroad only had two locomotives, and they collided, the maintenance expense that year would not exceed five cents; it does not mean that if there were so little business that each locomotive only made 10,000 miles in a year, five cents could be realized; it does not mean that every locomotive or every division will come down to five cents, or that any locomotive on some divisions will come down to this figure. It does mean that any railroad with 10,000,000 miles a year of mixed freight and passenger service ought to maintain its power for $500,000.

We actually find, however, astonishing variations for similar operations. Comparing the locomotive maintenance costs of five trunk lines operating between the same terminals between 400 and 500 miles apart, under largely similar conditions, in round figures, it costs:

Road A— 6 cents a mile.
Road B— 8 cents a mile.
Road C—10 cents a mile.
Road D—12 cents a mile.
Road E—16 cents a mile.

Assuming 30,000,000 locomotive miles a year, and a $0.06 a mile standard:

Road A wastes nothing.
Road B wastes $ 600,000.
Road C wastes $1,200,000.
Road D wastes $1,800,000.
Road E wastes $3,000,000.

My assistants and myself have been in the shops of all these companies, and, as to a large part of the loss, we know, in part, why and where it occurs. If, as to every minute operation, there were a standard and a record, showing actual cost compared with standard cost, it would be easy for every man, every foreman, every superintendent, to check what was going wrong.

Many railroad records are not available for six weeks after the fact has occurred, and as to many facts not available for more than a year. It has been my experience that if you give a fireman a water-glass and a gauge, he will watch them, and make a strong effort to maintain standards; and it has also been my experience that if standards are supplied to shop and track men and if records are available from hour to hour, a strong effort will be made to attain and maintain standards, and that it is much easier to maintain a shop or round house efficiency of 99.96 per cent. as it is to maintain this efficiency in a train schedule.

In a very large locomotive shop conditions were first standardized, and then standards of performance were furnished. The shop went on as before, same equipment, same work, same men, same foremen and other officials, but standards as to his own particular duties were set up for every man.

The results were as follows:

Month.	No. of Men.	Stand. Hrs.	Act. Hrs.	Eff.
1	21	2,011.2	3,613.9	55.6
2	50	4,350.2	7,418.8	58.6
3	77	7,649.6	12,748	60.
7	251	27,051.8	41,463	89.3
12	656	122,736.4	126,534.4	97.
13	731	120,357.5	120,478	99.9
14	771	148,841.	146,434	101.7
15	819	155,276.5	160,701	96.5

The 819 men have by no means reached the highest efficiency, as is shown by the table of classification below; average wages assumed at $0.30 an hour and working hours at 250 in the month.

Workers	Av. effic'y Per cent.	Wages	Bonus Per cent	Bonus
61	30.3	$ 4,575	0	0
33	45.	2,475	0	0
50	55.8	3,750	0	0
72	64.6	5,400	0	0
216				
81	74.2	$ 6,075	1.1	66 82
76	84.3	5,472	5.8	317 37
74	95.	5,500	15.0	825 00
90	105.9	6,750	25.9	1,748 25
94	114.6	7,050	34.6	2,439 30
64	123.9	4,800	43.9	2,107 20
56	132.4	4,200	52.4	2,200 80
26	145.3	1,950	65.3	1,271 35
19	154.1	1,425	74.1	1,055 95
6	163.3	450	83.3	374 85
17	196.4	1,275	116.4	148 40
603		$61,147		$12,555 29

Total wages, $61,147.00.
Total bonus, $12.555.29.
Average bonus per cent to bonus workers, 27.9%.
Average bonus to all workers, 20.5%.

If 603 men out of 819 earn bonus, it is evident that the schedules are not severe.

In a particular gang of 32 men, an average efficiency of 95.8 per cent. was attained, standard time being 7.211.6 hours, actual hours 7.523.5. The highest man showed 139.2% efficiency, the lowest 7.8%.

Assuming the cost per hour of operation being $0.30 for wages, $0.30 for machine charge and $0.25 for overhead expenses on the man, we have an hourly average operating cost of $0.85 an hour. The man and machine work 250 hours in the month at a cost to the company of $212.50.

The table shows how the cost of work per hour varies as efficiency varies:

Efficiency per cent.	Hours worked	Hours standard	Cost per mo.	Cost standard hour.	Relative costs.
60	250	150	$212.50	$ 1.42	167
100	250	250	$212.50	$ 0.85	100
140	250	350	$212.50	$ 0.61	72
8	250	20	$212.50	$10.62	1248

I have seen the engineer of the Lusitania lying in his berth watching the record of the R. P. M. of the propellers. He did not have to take any observations of the sun or stars or heave any log to know the distance traveled. The speed of vessels is determined solely by the speed curve of revolutions of propeller. Similarly, if we have an efficiency record, we do not need any cost statements. We know what they must be.

When conditions and operations are standardized, it is known in advance when the work is to be done, how long it will take, and what it will cost. Every job is dispatched on the basis of a time table. Conditions are standardized, the same high efficiency in men, machines, methods and materials is expected and attained as the Pennsylvania Railroad or the New York Central attains with its 18-hour train.

It is possible to go on any railroad in the United States and check up the losses occurring with closely the same definiteness that it is possible to check up the total time that trains are late. It is possible to go on any railroad and furnish its executives with methods that will enable them to eliminate the stupendous wastes. It takes time and effort and experience to put in adequate methods, but it pays.

The methods are not empirical. They are based always and solely on the principles stated.

PRESIDENT: I presume there are quite a number here who will want to discuss the principles enunciated by Mr. Emerson, but I do not know you all and there will be some we will miss unless you get up voluntarily. I will ask Mr. Turner to open the discussion.

MR. L. H. TURNER: Mr. Emerson occupies the position of a public educator; his work has attracted the attention of the railway world of this and of other countries, and in consequence he has become a national character, a disseminator of knowledge that is of the utmost importance, not only to railroad operation but to every industry in our country.

The discrepancy between the results actually obtained and those which it is claimed we should obtain, is so great that either our railroads are far from being operated intelligently, or Mr. Emerson has failed to take into consideration some conditions with which our railroad managers have to contend.

I am sure that Mr. Emerson is so broad-minded and so well fortified in his position that he will take no offense and will not misunderstand our motives if we endeavor to make clear our views and strive in this way to gain a greater and a broader understanding of this vital question, which means so much to the companies that employ us, and to our reputations as managers of men and equipment. What I shall have to say is not for the purpose of appearing antagonistic to any system that Mr. Emerson may advocate. We are "seekers after the truth," and we want to know. It is no violation of confidence to say that the "betterment work" is regarded with some suspicion by men who have built up a very fair reputation as efficient managers, but if this system is based on the principles of truth, and can be demonstrated, it is bound to live, regardless of what I or others may say.

If it is not, and is too ethereal and idealistic, it will not survive, regardless of what Mr. Emerson may say.

In the paper we have heard read tonight, it is stated that "efficiency" is gained through a greater or lesser observance of eight laws. These laws as laid down are good, and I do not understand how high efficiency can be obtained without the full and complete observance of all of them, but while our intentions may be of the best, there are many obstacles far beyond our control which will operate against the fulfillment of these laws. Law No. 1 says, "There must be common sense." Of all the qualities with which the Creator endowed mankind there is none of greater scope and none so necessary in the making of a well-rounded-out man as that of "common sense." A man may not be a genius in any direction, he may have been unfortunate in birth, environment, and may lack opportunities, or possibly be blessed with only average intelligence, but if he has common sense there are few, if any, situations in which he can be placed that he will not rise above circumstances and land on his feet. On the other hand, there are many men who hold good positions, are experts in some particular line, but who display the rankest judgment in the ordinary affairs of life, particularly those which most affect the welfare of their families and themselves, and unfortunately men of this type are largely in the majority.

Law No. 2 says, "There must be discipline," and the comment on this is, that many railroad presidents make official complaint of the lack of discipline on their roads. In times of unusual industrial activity, accompanied by a heavy grain movement, good reliable men are hard to obtain and retain; they are in great demand, and men of this type always make up the minority, the balance being composed of those who do not overwork themselves in studying the interests of their employers, and who oftentimes take advantage of the scarcity of help to gratify their inherent love of meanness by staying away from their work simply for the purpose of illustrating to the "boss" how much he needs them, and committing lawless acts while on duty if there is a possible chance of their doing so without being detected. The man in charge knows that the president expects the business to move, and also knows that he has neither the time nor the disposition to hear his "tale of woe," and in consequence he shuts his eyes to many breaches of discipline, as any man in his position would do, and the president, if he is a man of common sense, pats him on the shoulder for doing so. Lofty ideals and high standards are beautiful to contemplate, and uplifting in their effect, when indulged in while seated in comfortable office chairs, but in poorly heated engine houses and classification yards blocked with snow, your dreams of 100% efficiency fade away and you work on the principle, "If you cannot get what you want take what you can get."

Law No. 3 states that there must be a "fair deal." Conceded without argument.

Law No. 4 says, "There must be adequate and reliable records." Admitted, if records are not too numerous and reliability thoroughly established.

Laws 5 and 6 state: There must be "standardized conditions" and "standardized operation," both of which are absolutely necessary in order to reach a high state of efficiency, but correspondingly hard to attain. As they contemplate extreme watchfulness on the part of those ordering material, prompt delivery of the same, and most regular service on the part of workmen, a shortage of material, scarcity of help, unsteady workmen, or accidents to machinery and power plant would immediately disarrange the most perfect system the brain of man can devise.

Law No. 7 says, "That every worker, from the president down, should be compensated on the basis of his efficiency." What should be done is widely apart from what can be done. As an illustration, one railroad may be built on easy grades and curves, with quick access to large industrial concerns, mines, etc. Another may have high grades, bad water and scarcity of tonnage-producing properties. As the cost of operation is decided wholly by the ability of the staff officers and by the physical conditions of the road, it would seem difficult to determine to what degree the president working under favorable conditions is superior or inferior to the one not so pleasantly situated, and what is true of the president is also true all the way down the line. It would be difficult for any man to do the same job on both sides of an engine in equally as good a manner, and in the same period of time, owing to difference in the hardness of material to be removed by file or scraper, bolts breaking or hard to remove, inaccuracies in machine fit, etc.

Further comment on law 7 says, "Standardize the wages and the minimum equivalent for the wages." How we would love to do this—but your standard of wages is completely demoralized the moment your neighbor raises his hourly or piece work rate, and he will do it as soon as conditions at his shop demand more help and his rate of wages will not draw the men from his neighbor's shop to his own. Neither can you afford to dismiss John Jones because he may not be able to turn out quite as much work as Tom Smith. As long as the world stands, some men will be able to produce more than others, although both have equally good intentions, and none of us will ever be able to assemble under one roof all of the good men to the exclusion of the poor ones.

Efficiency consists, not of doing only one part of your work well, and that at the expense of the balance, but of doing all of it better than others, and doing it every day in the year. The mention of the movement of the Pennsylvania and New York Central Lines eighteen-hour trains is not a fair illustration of efficiency and is misleading to the uninformed. There is no doubt but that both lines are making wonderful records, but at the expense, however, of the movements of every other train on the division at the same time and going in the same direction. Everyone on both lines who has anything to do with train movement is under the strictest orders to subordinate everything that would in any way conflict with the movement of these two trains. All other trains are side-tracked, and excepting accidents, the men handling these trains have no official knowledge of any other train being on the line. The road is open to them from New York to Chicago, and woe to the man who delays them. Should one or both of these roads attempt to run twelve of these fast trains daily, spaced two hours apart, and maintain the same efficiency, their lines would be impassably blockaded from terminal to terminal within one week, and for this reason we insist that "efficiency" does not consist of doing one per cent of your work on a high standard and ninety-nine per cent of it immeasurably below it.

In the December, 1906, issue of the *American Engineer and*

Railroad Journal considerable space was given to the exploitation of the "Betterment Work" of the Santa Fe system. We assume that the information given is authentic and issued by the management of the railroad. We also understand that this betterment work was originated and installed under the direction of Mr. Emerson. Certainly no criticism can be offered as to the completeness of the system, unless it be that it requires too much in the way of clerical work and inspection. In discussing rates of pay, we feel that it is better to come right out into the "open" and view the subject as it is seen by both employer and employe. We must not think that our men are not able to analyze schedules and determine for themselves whether or not they are being compensated sufficiently for the extra effort they are putting forth in order to earn the "bonus," for they understand that any expenditure of energy beyond that required to perform a normal day's work, or any effort which overtaxes their strength, shortens their term of earning capacity, and no man, whether he be president of the road or wiper in the engine house, cares to exert himself to a point that shortens his life or hastens the day of his retirement. As an illustration, we will look into the schedule that determines the wages of men in the link gang. In a fifty-hour week, turning out five engines, gang cost, $180.00, costing the company $36.00 per engine, no bonus is paid. In a fifty-hour week, turning out six engines, gang cost $180.00, costing the company $30.00 per engine, a $10.00 bonus is paid. The company has saved $26.00 and turned out one more engine. The men received $10.00 for an expenditure of 20% more energy. The $10.00 bonus will not amount to more than $1.00 per man per week. For a fifty-hour week, turning out seven engines, gang cost $180.00, costing the company $25.71 per engine, a $21.60 bonus is paid. The company has saved $51.43, turned out two more engines, and given the men $21.60, or about $2.00 per man per week, and the men have expended 40% more energy. When the gang have doubled their output and the cost per engine to the company is $18.00, the bonus is $64.80, or about $6.50 per man per week. The company has doubled the output and saved $115.20 in the transaction; computed on an hourly basis the men have increased the rate per hour from 36c to 49c. Assuming that the men have doubled their output and increased their rate of pay 36%, this fact is made use of at once to have the hourly rate advanced, and if they are persistent enough, and are in a position to enforce their demands, they succeed. Then they relax their efforts and fall back on the day rate, resulting in reduced output and an increased shop cost. This is not a suppositious case, but has actually taken place.

In this schedule provision is made for the men to increase their output 120%. This, we believe, to be practically impossible, unless the shop management was extremely bad prior to the introduction of the betterment system. It may be said that the men use their brains more, which is perhaps true, but at the same time brains cannot do it all, and if under any circumstances except improved machine tools a man can double the amount of work turned out, the place to commence reform in that plant is with the shop managers, regardless of title.

Men employed as managers of mechanical departments of railroads are in self-defense and in justice to themselves bound to take exception to some statements made and figures given in Mr. Emerson's paper. For instance, he states that one road maintained its cars for $37.00 each per annum. Freight cars are making about 8,400 miles per year; this brings the cost per car mile for repairs to $0.043, and it is stated that these cars were 6,000 pounds lighter and cost $100.00 less to build than those of another road that spent $100.00 per year for maintenance. This seems inconsistent, as weight in a car, if properly distributed, adds strength and will reduce the cost of maintenance. The light car should ordinarily cost more to keep it going. It is safe to say that $0.070 per car mile is a very fair average figure for maintenance throughout the country. While the figures given are undoubtedly correct, a statement should have been made as to the conditions under which the two roads were working. The $37.00 man may have had a lot of new equipment, or may have been slighting his work, while the $100.00 man possibly had a lot of old equipment, badly run down, and may have been trying to build it up and doing the work that his predecessor had neglected.

Mr. Emerson has also stated that any road east of the Rocky Mountains making 10,000,000 locomotive miles per year, should maintain its equipment for $500,000.00, or 5c per mile, and that 4c should be striven for. Had Mr. Emerson qualified his statement by specifying the weight of the equipment that should come within these figures, it would have had some weight, and carried more conviction with it. There is a vast difference between maintaining a lot of engines with an average tractive power of 20,000 pounds and another lot with an average tractive power of 30,000 pounds. Few of the best roads in the country get down to even 6 cents per mile, and they are equipped with up-to-date shops and in charge of some of our brightest mechanical men. No man rests easy when he knows that he is wasting millions of his employer's money each year, and no statements should be made that cannot be demonstrated and considered as reliable. We have a case in this country today of a superintendent of motive power who built up a very enviable reputation for maintaining an equipment at a low cost, and through this reputation secured a good position with a large manufacturing company. His successor on the railroad, however, had to increase his cost about 33%, in order to perform the work that should have been done by the low-cost man.

Our country is suffering from too many "short term record makers," giving short, spectacular performances, but who eventually sink into obscurity. Every mechanical man in charge of a large equipment is prompted, not only by personal pride but by a desire to maintain a good position among other lines for cost of maintenance; he is willing and glad to follow any new methods that will aid him, but he does not like to have "impossible performances" held up as a model for his guidance. The work in which Mr. Emerson is engaged should be prolific with good results, but we believe he has placed his standards too high, and has aimed at results which can never be attained, and in consequence are not taken seriously. The New York *Times* of August 2, 1908, makes Mr. Emerson say that the annual loss to railroads in this country due to wastes is $300,000,000.00, or about 12% of the gross earnings, and 18% of the cost of operation. In this article he has enumerated many ways in which this waste occurs, but has, for some cause or another, failed to offer a single remedy, except to advocate his system of building up "efficiency," which is so loaded down with theories, "stop watches," voluminous reports, dispatching boards and other things, that lead the men who have been able to earn $2,590,000,000.00 at an operating cost of 67% of the gross earnings, to feel that his system is not only impracticable but impossible. There is no part of railroad work that has not received, through newspapers and magazines, Mr. Emerson's most careful consideration. In the interview given above, he has shown how six cars destined from San Francisco to Omaha were not placed in the train in station order and had to be switched at Omaha at a heavy cost, but has failed to show why it costs more to handle a car in Omaha than it does on the Pacific Coast, nor did he state what conditions may have existed on the coast which might have made it desirable to switch them at Omaha. A little road running into this city has to make 65 classifications of its southbound cars at the north end of the line. The yard is bounded on one side by a river and on the other by a thickly populated hillside and another railroad. The management of this little railroad will pay big money for some system of "efficiency" that will enable them to build 65 tracks on a piece of ground that will hold only 36. In the interview given above, Mr. Emerson has made a wholesale charge of inefficiency, ignorance and neglect against every man in this country in charge of railroad operation by saying that "they have no conception of the results they could achieve by endeavoring to bring their staff up to the highest average of efficiency." You will note that they do not know what they can do and have made no effort to find out. Mr. Emerson says that a vice-president getting from $10,000 to $15,000 a year cannot be expected to give careful attention to details, and that they are handed down from one official to another until they land in the hands of a $50 a month man, and thus the great railroad systems are ruled by $50 a month judgment. All of you will concede that when we try to understand the great amount of work and the multitude of duties connected with the operation of our large railroad systems, that we are growing some very able $50 a month men, but still no remedy is offered. Missouri is an old State, her citizens and their posterity are widely scattered over our country, and they want to be "shown." I voice the sentiment of the railroad management of this country when I say that they are tired of assertions with nothing behind them. If Mr. Emerson presumes to pose as an authority on all matters pertaining to railroad operation, and wishes to be recognized as such, when he makes the assertion that such inefficient management exists he must not only provide a remedy, but must demonstrate that the remedy is practicable, and until he does this his system will be regarded as effective only in destroying the individuality of the man, making him not only a part of the machine but a discontented workman as well. If he can convince us that we are wrong we are more than willing to be converted to his opinion, and in doing so he will confer a substantial benefit upon the railroad and industrial world, and build for himself a reputation to be envied.

PRESIDENT: I have the card of Mr. Oscar Otto, General Superintendent of the Westinghouse Machine Co.

MR. OSCAR OTTO: We have this plan started in our East Pittsburgh plant, but as I have only been with this company two months, I have not had time to look into it carefully. Our Mr. Kinsell is here and he may be able to give you something valuable.

PRESIDENT: I see Mr. I. B. Thomas, Master Mechanic of the P. R. R. at Altoona. We will be glad to hear from him.

MR. I. B. THOMAS: Mr. Chairman and gentlemen, Mr. Turner has certainly brought out some of the points in a way that appeals to most of the railroad men present. I have no doubt all of us have had a great deal of "efficiency" rubbed into us in the past two years. Various articles published in different magazines have naturally attracted the attention of the management and each one of us has had certain things pointed out to us and I guess we have all studied the problem pretty hard.

There are one or two things I would like to bring out. In the diagram we have rather a remarkable reduction in the cost of maintenance of locomotives from $2,300 a year to $1,243. The conditions under which this was obtained are, of course, not stated, but it is stated that there was an increased mileage per locomotive failure. The question would naturally arise what is a locomotive failure. Each railroad has a different system of determining that and I believe we would all be glad to have something definite on that point. I think these are possibly comparative. The figure later on is given at 5c per mile for maintaining locomotives. Now it is rather doubtful whether the road in this diagram is actually maintaining its locomotives for 5c a mile. Personally I know of but one road of any size that is down to

5.30, and that is a road in the Middle West where the conditions are such that it is probably perfectly practicable to maintain it in proper condition for that figure. If the figure of $1,243 is at 5c per mile we get about 2,000 miles per locomotive per month, which is not a very large mileage, although on a mountainous road not many are going very much over that on the average for the entire equipment, including shifting service.

MR. EMERSON: This diagram does not include all the expense of maintaining a locomotive, and on this road the locomotives are not maintained at 5c per mile.

MR. THOMAS: Then the condition of $2,300 would be one where there was certainly seriously bad management to start in with, a condition where almost any one familiar with railroad operation could walk in and make a showing without very much concern to himself.

Mr. Turner has already called attention to a qualification of the statement and it would seem to me that it might be further qualified. There are certainly railroads operating east of the Rocky Mountains that have as difficult conditions to meet as roads in the Rocky Mountains taken as a whole. There may be an individual road in the Rocky Mountain that has a longer average grade than any road east of the Mountains for any quantity of service; on the other hand very few of such railroads have that condition as a major portion of their business. With any of our coal roads in the east, with our present equipment to attempt to operate on 5c per locomotive mile means one of two things: either, as has been suggested, the next fellow that comes along has to pay for it, or the railroad is already paying for it in inefficiency of service of other kinds; that is, that break-downs and lack of hauling capacity will soon cripple the other service so as to make it very cheap if you went up from 5c to 9c per mile.

The next question comes in regard to fixing a "standard" and which applies directly to this matter of rate per 100 miles. We all know that there is a great difference in loading of locomotives on different divisions of the same railroad and of different roads. We may have had a condition, such as the Lake Shore, where a great deal of their track is two tracks, a large amount of passenger service, probably 45% to 50%, and quite a large part of the balance is high-class freight. The low-class freight, in order to get over the road, must make pretty nearly the same time as the high-class freight and passenger trains. Necessarily their loading per locomotive is low and under those conditions you have an opportunity to maintain a locomotive at lower cost per mile than under the same conditions with a heavier loading and a drag freight. Furthermore, the locomotive is making many more miles per month and at no expense to the action of the machinery.

Coming to a road that has a very large quantity of slow freight and a small quantity of high-class freight in comparison, their average speed is very much less and if they have terminal facilities they can afford to load their locomotives to a maximum and get all the work out of them. In the end that will cost more per locomotive mile than for the other road. On the road with which I have been connected, in the past five years the average tractive power of locomotives was increased 16½%. Now you cannot put 16½% increased average tractive power in locomotives and maintain them for the same cost per mile, if you are getting efficiency out of them. The road that is spending 16c per mile is probably spending higher than they should, due to some inefficiency of operation, but I believe there are several roads, or at least divisions of roads, where 10c or 12c is a proper figure, simply due to the physical condition of the railroad and the fact that they are getting a maximum loading out of their engines and can afford to do so under their traffic conditions. The road in the Middle West which I mentioned as getting a figure of about 5.30 had been running at something over 4.70 before that time, simply due to the fact that their equipment has increased in size, and from what I was able to see, in the next two or three years they will pass the 6c mark. Yet I believe that railroad is operating efficiently as far as the motive power end of it is concerned.

When we go forth to the matter of establishing standards, on a road which is operating on the bonus system and with which Mr. Emerson was connected, the standard for general repairs to locomotives was either 14 or 15 days, I am not sure which, and that was put down as a standard to which you were to work. It is expected that under some conditions you will hardly reach 100% efficiency. Now the shops with which I am connected expect to turn out such a locomotive in 6½ to 7 days and are doing it right along. Is there any reasons why the standard of efficiency in a comparatively well equipped shop should range from 14 to 7 days? It does not seem to me that that is really a standard. If you compensate your foreman and general foreman of the shops on the efficiency basis you immediately introduce a tendency to make the standard high so the efficiency will be high. As a matter of fact, I think you will find that is the case in shops where the bonus is used. Notwithstanding the fact that they have a very efficient staff organization which is there to see that the bonus is set right, that is, that the standard is made right. If a foreman feels that by getting a standard a little bit higher he can increase his earnings it will certainly open a way for standards which are not on the proper basis.

It seems to me that in order to properly organize a shop or any other operation the first thing necessary is to put the right man at the head of it, a man who is familiar with methods of organization, familiar with men, who when he has had a short conversation with a man can make up his mind whether he can trust him or not, and put it up to that man to pick out the right men for the right places. He must go through his organization from top to bottom and practically systematize it, decide what positions are necessary and see that he has the right man in each of those positions. And then he will find that the organization is not self-sustaining. He will find that in a reasonable size organization he will have a great many changes to make from week to week and month to month, due to causes not within his own control. Somebody wants the good man and will pay a little more for him and get him. Then he has to hunt another fellow. That process of hunting the other fellow goes on continuously, and unless he gets the right type of man no system of standard or any system at all will carry along with any degree of efficiency. In order to get this right man he must spend some money to educate him. He has to use every opportunity there is to try them and to place those men in positions of responsibility until he can find out whether they can stand it, and if they can he should be appointed. And then he will find he will have the same thing to do over and over again, and in a large organization he will find that is the biggest part of his job.

Along with that, of course, goes the maintaining of discipline and the other points mentioned, and in order to maintain that discipline it seems that he must see that each man in those positions is properly instructed in his duties and is kept so instructed. Failing in that, he cannot have an organization of high efficiency, regardless of what methods are used. I thank you.

MR. HENRY GILG: Mr. President, Mr. Emerson made a remark about efficiency which I understood to mean as giving a bonus to a man who does the work in less than a specified time. I had to work at one time under a proposition which stated specifically that no rewards were to be paid, so I had to fall back on the adequate records. Now there came within my own observation two plants in this city in a like business, both of which had adequate records, one of which companies closed down for three years and paid all its charges and the other of which only escaped the receiver's hands recently. If Mr. Emerson's ideas were carried out on all the railroads of the United States the conditions would bear the same relation they do today. As Mr. Thomas said, if you have not the man at the head of the organization you will not save the money.

PRESIDENT: Mr. Elmer, would you like to talk on this subject?

MR. WILLIAM ELMER: Mr. President and gentlemen, I think we all agree that destructive criticism is the easiest thing in the world. I have not had the pleasure heretofore of meeting Mr. Emerson and I think this a good opportunity to ask him some questions, because I may not get another chance. I would like Mr. Emerson to touch on the particular problem in which I am interested. The division with which I am connected is practically a large engine house. I would like to know just how Mr. Emerson handles the problem of definite times and bonuses for engine house operation. After quite a number of years of investigation on the part of the P. R. R. and the comparing of various methods which were in use on other railroads a committee some years ago developed a scheme of card for timing the operations. John Smith will be given a job to plane a set of guides. The time he started to work would be noted on his work slip and the time he completed the work would be noted. Various other men throughout the shop would have the same job. These cards would be compared and eventually some data would be obtained. That method of timing was advocated for our engine houses and after a good deal of time we reached a form. I have with me a set of the forms we use.

I must say that the problem of getting exact data on various operations has always appealed to me as being very difficult in an engine house. Even granting that we have the different operations so definitely described and the conditions so nearly reported that we can set a certain definite time for performing a certain operation, we then are confronted with variations in the amount of business going on at any particular point during any given hour. I have had careful records made and they show that the time a man is at work in the shop and the hours he is in the shop vary very widely. We cannot expect our men in the engine houses to have a job always before them, and we must make our rate of pay sufficiently high to attract the men to do the work. I think perhaps I could accomplish more good if I had Mr. Emerson off in a corner.

PRESIDENT: I find we have with us Mr. P. J. Conlon, First Vice-President of the International Association of Machinists. If there is any man or set of men interested in the efficiency system or the bonus system I would think that it is machinists. Perhaps Mr. Conlon will tell us what they think of the system.

MR. P. J. CONLON: The machinists throughout the country are working premium systems under several different forms, though much against their will. It seems now and then we have a spasmodic effort to increase the output and some new fad or fancy comes to the front of doing work systematically. We have at present under the name of the Premium Systems the Halsey System, the Bates System and the Stevenson Individual Effort System, the DuBrul Card Index System, the Profit-Sharing System, the Standard Time System, the Gang Contract System and the Merit System, whereby jobs are timed by a Bunday Recording Clock, and no set premium is paid, but merit is rewarded according to the judgment of the foreman or proprietor and short time is likewise punished according to the circumstances. Of all these systems the Standard Time System has so far proven the most unsatisfactory to the men working it.

The American Locomotive Co. adopted the Standard Time System about two years ago after two years' experiment, with much industrial trouble in the way of strikes with the machinists and boilermakers, and at a cost of nearly $800,000 have finally abandoned the system as unsatisfactory. I have had some experience with the effort of that company in trying to successfully operate standard time, and had an opportunity of getting some figures regarding the cost of maintaining the system. If you will recall the fact, some time in December, 1909, some 295 men rebelled against the Standard Time System in the Manchester works of this company in Allegheny, and went on strike after protesting against this system for a period of two years. I was sent to try to adjust the difficulty, and in an interview with Mr. Gurry, the superintendent of the plant, he informed me the local cost of maintaining the system in that one plant alone was over $4,000 per month. Later in trying to adjust the difficulty it was necessary to go to the general offices of the company in New York City, where I met First Vice-President David Van Alstyne. In talking matters over he informed me that the American Locomotive Company found the Standard Time System a profitable investment, and when I cited to him the heavy fixed charge in clerk hire he informed me that even under that handicap it was profitable. This naturally left me under the impression that the men in the shop who were working as machinists and boilermakers must be carrying this burden of clerk hire out of their supposed bonus, so I resolved to make an investigation on that score. I returned to Pittsburgh and interviewed the men as to what they received in the way of bonus and in what manner it was paid. I was then told the methods of taking what is known as time study to determine what is known as standard time, but what is in reality the minimum time. For instance, say that the time study was to be taken on the turning of a crank pin. The operator would be told to get his machine in readiness, his tools sharpened, his belt tightened and on the proper cone, and when everything was in readiness, under the most favorable circumstances the time study would be taken by a stop watch, every movement in the operation being timed to the fraction of a second. For instance, so many minutes would be required to center the pin, so many seconds or minutes, as the case may be, to fasten the dog or driver, so many minutes for placing the pin between the centers in the lathe, so many minutes to take a roughing cut across the pin, so many minutes for taking a finishing cut across the pin, so many minutes for facing off the ends, so many minutes for working out the corners, so many minutes for making the fit, etc.

Now all these operations would be added up upon completion of the job and the combined time placed on the card as the standard time for turning a crank pin, and this time taken by a stop watch and under the most favorable circumstances, must be lived up to to enjoy what is known as 100% efficiency, which entitles the man to a bonus of 20 cents on the dollar based on his day rate if he can maintain an average efficiency of 100% for the entire week. But broken belts, dressing tools and grinding them, waiting for card, dispatching cards and failure to find the necessary clamps and bolts play havoc with 100% efficiency. The payment of bonus starts with 70% efficiency, so that when a man maintains an average of 85% for the entire week he would be entitled to a bonus of 10 cents on the dollar, and so on up to 100% efficiency, which entitled the man to 20 cents on the dollar.

In making my inquiry regarding the bonus paid I was surprised to learn of the few who had received any bonus, so started out to gather a number of pay envelopes at random to satisfy myself as to what extent it was being paid. I have here in my hand 38 pay envelopes that I thus secured, belonging to men who were working for the American Locomotive Company during the week ending November 20, 1909, as machinists. These men are still working for this company and their shop numbers are on the envelopes, together with their earnings and bonus paid, and I am going to leave them with the Club for verification if necessary. This is what the envelopes say: The aggregate earnings in these 38 envelopes was $510.86 and the total amount received in bonus was $6.57. The highest bonus paid was 72 cents and the lowest was 2 cents. Fourteen men of the 38 here represented got no bonus whatever. However, the matter of bonus does not concern us, as we much prefer any bonus or premium the company might see fit to bestow upon us to be added to our hourly rate, but what did concern us was the marking down of efficiency which constituted a cause for dismissal if not above 69%. It was brought out in the investigation that men were required to wait in line around the card dispatching room to turn in their cards after the job was completed. In some cases the company had only a limited supply of hand tools for men on the floor, such as taps, reamers, etc. Another instance was brought about where a drill press boy went to the card dispatching room twenty times in one hour for time cards to drill holes. Well, you can imagine where that boy's efficiency record went if he had to spend from two to three minutes waiting on the card. The system is called standard time, but it is anything but standard time, because the standard is so continuously changing that it is necessary to keep a record of the different standards. For instance, if a man should be fortunate enough to maintain an efficiency of 100% for three successive weeks, either a new time study is taken upon his particular work or the man himself is promoted to be a time study demonstrator. So after two years of trouble and expense the American Locomotive Company has returned to the old piece work system, and while even that system of doing work is not satisfactory to the machinists generally, of the two evils we prefer it to the Standard Time System.

We must all appreciate that we have good and bad days in a machine shop. I have been at the machinist business for over 25 years and, by the way, I was a cub under your honored president at Pine Bluff, Ark., some twenty-five years ago, although perhaps he does not remember me. I have worked at all branches of the business and worked in a supervising capacity and worked men. I know men and know their failings. A man will occasionally have his blue Monday or off day, but he generally makes it up, and we have loafers—some have the matter reduced to a science—but that is a question that can be remedied by supervision. After all, the question of the survival of the fittest will regulate the shop if common sense is used. Mr. Emerson cites in his paper that certain roads are so managed and standardized that natives can assure themselves of the time of day from the passing of the trains, and I take it that he infers that this system of standardization could be carried to other departments on the same parallel; that is, if things were running right in a shop working standard time successfully you could almost tell the time of day from the amount of completed work on the floor, and taking the standard time marked on the card as a basis of calculation. That might be so if we had castings of all one degree of hardness and tools that would not get dull, and belts that would not break, and hundreds of other things bound to happen that impair the efficiency record and creates a spirit of antagonism to the system which sooner or later works itself into open rebellion. We have also to appreciate that when a new man comes to work after the dissatisfied one has quiet and left the service and he is shown one of the standard time cards with the time reduced to the irreducible minimum, he is not going to grow very enthusiastic over his new job, and is more liable to get somewhat afraid of the record set for him, and get ready to quit before he really gets started, so taking the matter all in all I am of the opinion that the method of working standard time will bear investigation before being adopted.

MR. F. H. STARK: Mr. President and Members of the Railway Club of Pittsburgh, I have listened to the very interesting remarks made by the author and the other gentlemen that followed.

The author in his paper lines up his Gatling guns, blazes away broadcast and as the smoke clears away inquires: "Are any of yees hurt?" Or in other words, he makes a charge of gross carelessness and ignorance against the management of railroads in general and then apologizes by stating that he does not intend to slander any particular interests, but states that it applies practically to every railroad. He might have consoled us by qualifying his statements by reminding us that all railroad men are overworked and underpaid, and in consequence of that, few intelligent men follow railroading. Mr. Emerson's apparent estimate of the average railroad general manager might be illustrated by repeating the old threadbare story regarding the alleged interview between a section foreman and general manager. The section foreman secured an audience with the general manager and advised him that his son had recently concluded his school work and he was anxious to secure a position in the general manager's office, remarking that possibly the boy might become a trainmaster, later on superintendent and if he had good luck might some day become a general manager. There being no vacancy in the office the general manager advised the section foreman to start the boy in on the section and that it would be an advantage to know more or less about all branches of service, and that no doubt he would soon be made section foreman and thus be in line for an advance, when the father remarked that he was fearful that Mike would not make a good section foreman, and in a low voice told the manager that his son was not overly bright.

I assume that the author has made these sweeping statements in order to provoke discussion, and the fact alone that he has been invited to present a paper before the most successful railroad club in this country is evidence that he is a man of far more than ordinary ability and possibly before he gets through with us he may put us to shame.

There is so much that enters into this proposition that we must be conservative and weigh the evidence carefully, for it is an easy matter to deceive ourselves, especially if we are over-enthusiastic along a certain line of thought, hence it is not well to make hasty conclusions.

On one of the pages the author refers to the increase in the efficiency from 55% to 93% accomplished with the same general conditions. This would indicate that something was radically wrong with the previous administration or is it possible that they did not use the same yard-stick in measuring the efficiency before and after. Of course, the author no doubt is in a position to satisfactorily explain how the results were accomplished. The author refers to a road maintaining its equipment for $37 per car per annum. I would like to ask Mr. Emerson whether the figures include depreciation. It is a physical impossibility to maintain the average rolling stock for such a figure. If you will ascertain the aggregate cost for inspection of freight cars and divide the same by the number of cars owned, you will be surprised at the cost per car for inspection only.

The average life of car wheels on many roads will not exceed four years, which amounts to approximately $10 per car per annum. The cost for M. C. B. couplers and their attachments will approximate $10 per car for renewals. Take into account the frequent renewal of journal bearings, air hose, brake shoes, etc. Add to this the heavy repairs on account of natural wear and accidents and a railroad that keeps it accounts in proper manner will discover that it cannot maintain its rolling stock in a good safe condition year in and year out for $37 per annum, exclusive of depreciation and interest. Such conditions would only be possible for the first year or two with all new steel cars.

I read a statement in which the writer contended that railroads were operated more extravagantly than any other system. I believe you will bear me out in stating that there is a great deal more waste in federal, state and municipal administration. Railroad operations are so diversified and spread out that it is impossible to give the details the same consideration that is given to private or corporate interests not so scattered. Then, too, railroads are semi-public institutions and are subject more or less to public sentiment which cannot be ignored, all of which requires much of the railroad official's time.

The published proceedings of the American Railway Association, the Master Car Builder's Association, the Master Mechanic's Association, the Master Blacksmiths and Painters and the various railroad clubs for years have been active and the records are replete with live subjects for discussion relating to every phase of railroading. The question suggests itself, "Has anyone discovered anything new?"

Discipline:—I never have had any military experience. I may have been a soldier "on the job," hence I do not appreciate the term discipline. I acknowledge it is absolutely essential, but not through fear. The best service cannot be rendered through force or arbitrary dictation. I believe the greatest loss to railroads today from an operating standpoint is lack of loyalty. The author would correct this by a "fair deal." Herein lies the meat of the whole matter, but how to accomplish it is worthy of consideration. I often wonder if the consolidation of interests does not have unfavorable effect, a branch of a system, formerly an independent road, loses its local identity, the employes and patrons are more remote from the governing power. Both lose their individuality, hence interest and loyalty wanes.

The demand and supply of labor has much to do with the government of men. The attitude of politicians and press molds public sentiment, all of which makes the problem more complex.

The sublime thought, "a fair deal," appeals to all. It will be realized when the natural propensities of men are changed.

Adequate and reliable records. We assume that there is too much red tape on some roads and not enough system on others. The character and extent of a system of accounting and checking, as the author has stated, should fit the case.

On account of the magnitude of the Pittsburgh Coal Co. business, with its hundred or more mines, dock facilities along the lakes and in the Northwest, and its numerous agencies, demands a complete system of accounting. Our people know every morning at 10 o'clock exactly the number of tons of each grade of coal mined the previous day. This involves regular and prompt telephone reports. Automatic calculating machines are used to ascertain the cost of operation of each mine separately. By transferring the charges to index cards in a short and simple manner, the distribution of payrolls, material used such as rail, ties, pit posts and numerous individual items of expense. In this way they are able to determine very early after the close of the month just what it costs per ton of coal mined for any and all of the various charges, all of which is absolutely necessary for successful operation.

In the conducting of any business it is not wise to devote too much time to little details and lose sight of the larger problems. In other words you cannot take too much of the supervising official's time at the expense of digging coal or the movement of cars, for the volume of business must be considered as well as the economical production of handling of same.

In considering this larger proposition of efficiency, the author might enlighten us on the following points:

1. *Common Sense*—If not exercised, why not? If not possessed, from whom can it be obtained?

2. *Discipline*—If it be mandatory or by mutual desire, if through fear will men stand for it? If through fear, can man do his best? Does not the supply and demand affect discipline? If so, how can we overcome it? Does not federal and state agitation make discipline more difficult? Is not loyalty more to be desired than discipline? Discipline does not imply loyalty. Loyalty begets discipline. Loyalty begets co-operation, honesty, faithfulness.

3. *Fair Deal*—Oh, thou jewel, where doest thou commence and where is thine end? Who are interested, the producer, the employed, the manufacturer, the commission or middle man, transportation interests, retailer, consumer, the public. Where is the righteous judge?

5. *Standard Conditions*—Who would decide the present or future policy? Will the controlling interest provide the capital? Generally speaking, are not the officials fully aware of the needs and resources?

6. *Standard Operations*—Who would decide as to the class, weight and number of locomotives and cars and the distribution of same? What the standard of physical condition of equipment shall be; what class of road bed, bridges, buildings, ties, etc., and just when the renewals are to be made.

8. *Efficiency Staff*—A specialist is an expert. He must know every detail of the subject or case, otherwise he cannot command the respect of practical men. There must be a sufficient number of competent experts to pass on every detail that arises in the operation of a railroad. The specialist must co-operate, not antagonize; should not manifest any direct authority; must not interfere with the responsibilities of the heads of departments. The work should be open and above board, with the absence of detective's methods.

The author no doubt will tell us how all of this is to be accomplished and how long it would take to do it.

PRESIDENT: Can we hear from any other gentleman? If not, I will ask Mr. Emerson to answer some of the kindly criticisms that have been raised.

MR. EMERSON: I see among the audience at least two of my friends and I would like to hear a word or two from them before I begin on my critics. Mr. Kinsell, whom Mr. Otto mentioned, also Mr. Powers, with Jones & Laughlin.

MR. W. L. KINSELL: I do not know just why Mr. Emerson wants to hear from me. We are looking into the work and finding out where we can make improvements. We have not gone very far, but we have changed our organization in such a way that now we know where to put our finger on the bad spots. The good places do not need any looking after at this time. We have not gone far enough for me to say anything about it as yet, but we are accomplishing results as far as we have gone.

MR. W. J. POWERS: I hardly think it would be safe for me to express my opinion; having been raised in railroad work I consider the remarks of the railroad men more on the defensive, as they are doing the work pretty well. I think all Mr. Emerson says is perfectly true, so that what they have said strikes me as purely a defense of their position. I think the statement of $300,000,000 a year is conservative, from the railroads I have seen, which probably will average up in efficiency with the railroads of the country. The Pennsylvania and also the New York Central Lines, I am satisfied, would contribute their share of the $300,000,000.

As regards the leader of the Machinists' Union here, I think those that have to do with the employing of machinists will be able to discount the gentleman's remarks a great deal. Being somewhat familiar with the American Locomotive Co. machinists I can hardly blame the company for not paying that 20% bonus for the amount of work they do.

MR. W. J. SCHLACKS: I would like to ask one question, if overhead charges, like any manufacturing plant figures in the cost of production, were in each case figured in Mr. Emerson's estimates into costs of repairs? We find railroads running into spells of things. For instance, I was connected with a railroad once that was neighbor of a line trying to make a record in oil, that turned over to us 25 stock cars at one time that we had to send back for them to put packing in the boxes. They had taken it out to let us put it in, and that is the way they were making a record.

There are so many different conditions that it is particularly hard to take one railroad's figures and apply them to another. For instance, Mr. Emerson's estimate of $37 cost of repairs per year on one car and $100 on another, and 6,000 lbs. average less. Maybe the road with the higher average had refrigerator cars, which everybody knows cannot be maintained on a low figure. Then the question of locomotive repairs. One man told me his company would not consider patching a firebox. Traffic was so congested that the results of a leaky patch would interfere with traffic to such an extent that the railroad thought it better to put in a new firebox than run the risk of a patched one. So far as cost of repairs per mile run, I was connected with a road which had 25% of its engine mileage as helper mileage. Those helpers would run up a hill 24 miles and run down again and burn their coal waiting for another train to come along. Those engines did not make many miles and their coal record was not of the best, naturally.

Railroads are accused of being more extravagantly managed than anything else in the country, except municipalities and the government service. That is due entirely to the fact that they are carrying on too many parts of their business. They are manufacturers and they sell transportation. They really do not sell, they manufacture. If they could divorce their mechanical departments from the transportation departments they could get at figures better to determine what the cost would be. For instance, overhead charges in the mechanical department should include switching charges. I do not believe any railroad ever considers the cost of switching for the mechanical department and often that helps out a great deal.

MR. THOMAS: I think the last statement should be corrected, because the Interstate Commerce rules make it absolutely necessary that all such switching charges be included in "shop expense."

MR. JULIUS KRAUSE: Mr. President, I wish to say a few words in Mr. Emerson's favor. I agree with him in a number of his ideas on efficiency. I will cite a case: While located at Pitcairn shop, about four years ago, two gentlemen, car shop foremen from the north, called at the shop wishing to examine the planing mill. I accompanied them and they were surprised to see center sills entering the mill at east end and pass over a line of machinery and pass out at the west end ready framed. The planer, cross-cut saw, gainer, tenoning and boring machines were all in line and the sills passed over rollers from one machine to the other. They made inquiry of the cost of framing sills, and when informed that the price was 19 cents, they doubted the figures, but finally agreed that no laborer was employed, and that they did not have their machines located in line, but had them scattered through the mill and carried the sills back and forward. This was lack of efficiency.

I do not agree with Mr. Emerson when he suggested to get your work done outside. I remember when W. C. Co. had their wheels mounted on axles by an outside firm, and when placed under cars a large number of the journals would heat, detain trains and destroy bearings. I was consulted and we made an examination and found the journals were not smooth. This was taken up with the firm fitting up the wheels, and the heating of journals were greatly reduced. This I call lack of efficiency, and in this case very expensive.

I can remember about 12 years ago when I was called up by our Superintendent of Motive Power and informed about the large number of hot journals on freight cars, and was asked if I had ever figured the expense of a bad case of hot journal. I had not, but was told to get busy. I found when a freight train is compelled to stop and carry water to cool a hot journal and carry sponging from cabin car to sponge journal, it would consume from 20 to 30 minutes and by that time, in some cases, were holding up five freight trains, and when I counted the cost of engine fuel, pay of thirty employes and the cost of new bearing and removing axle to have journal turned up, the cost amounted to $75. This was news to me, but it helped me to get busy.

I do not quite agree with Mr. Emerson's Lusitania story. I remember when I crossed the Atlantic Ocean, 57 years ago, on the steamship "City of Manchester," the first steamship that crossed the Atlantic Ocean, and it required 16 days. This vessel had a square hole in the center of deck with a railing around it, and when I looked down this hole I could see a water wheel, something like those on our steamboats on the Allegheny River. When at New York I visited the Lusitania, and the gentleman treated me very kindly and pointed out the turbine screws and their location, and stated they could shove this monstrous steamer across the Atlantic in five days. What a difference between 16 days and 5 days. This certainly points to efficiency, but Mr. Emerson will admit that 57 years of time are mixed up with this efficiency, and if Mr. Emerson will wait 57 years longer, the vessel may cross the Atlantic in one day and not touch the water at all.

MR. GILG: I want to ask Mr. Emerson one question: Do shop foremen and inspectors participate in the bonus?

MR. EMERSON: Under my particular system the shop foremen all do.

MR. GILG: Do you not think it would be an improvement if they were not included?

PRESIDENT: We will now ask Mr. Emerson to close the discussion.

MR. EMERSON: I have learned much that I know from railroad men. The best friends I have in the world are railroad men, and I have been more or less connected with railroad operation for 20 years. The principles I advocate or the remarks I make are not in any spirit of hostility against or criticism of railroad men, but the principles and methods are to be a help in the many and tremendous difficulties under which railroad operating and maintenance men work.

I have specified certain universal principles of waste elimination which apply to all human endeavor.

Wherever these principles are not applied wastes occur.

These principles are very inadequately applied in railroad operations and maintenance. There are, therefore, railroad wastes. Whether these wastes are more or less great is not the question. I estimate them at $1,000,000 a day. They may be greater or less, but in any case stupendous. If we take as our attainable minimum what has actually been attained as to a whole year's operation on large roads, the losses are more than $1,000,000 a day.

An operating official who had the best record in the United States as to locomotive and car maintenance told me it could be reduced 25%, not by skimping the work, but by working with greater efficiency.

The intelligent and consistent application of efficiency principles, through sufficient time will eliminate waste.

I have stated distinctly that methods may be infinite in number and that it is solely a question of expediency what particular method is used. Methods must, in fact, be subject to constant change. No baby lives without food. That is a principle. It may suck its mother or a wolf, it may be given cow's milk or Mellin's food, it may be fed from a bottle or with a spoon. These are methods. I have not advocated any particular methods.

Criticism should have been directed against the principles and if not against them against the possibility of putting them into effect.

I claimed specifically that the application of these principles can reduce locomotive maintenance to an average of $0.05 a mile or less and the maintenance of freight cars to $40 a year or less on the average. I could, in addition, have claimed that average locomotive mileage is far too low, that maintenance of shop machinery and tools is far too high, that both locomotives and freight cars cost more than they ought to, owing to the inefficiency of the plants that build them.

The ultimate aim of $0.05 has been objected to.

The ultimate aim of $40 a year has been objected to.

In addition, it has been stated that the efficiency methods I advocate have been given a full trial in the shops of the American Locomotive Company and been discontinued.

I claim $0.05 per locomotive mile or its equivalent of $50 per road unit, firstly because it has been attained by several great systems; secondly, because in checking up all the conditions and expenses of locomotive operation as to each locomotive of over 1600 for three years, I found that these figures had been reached in many instances, could be reached on an average for all.

There are similarly many roads that maintain their freight cars for $40 and they do not have particularly efficient shops at that. There is not a road with a $40 record that could not lower it to $35 by applying efficiency principles.

There are naturally good reasons why railroad maintenance is inefficient; there are excellent reasons why the American Locomotive Company find inefficient shops more profitable than efficient shops.

Railroad shops are inefficient because they are not the main business of railroading.

The main business of a railroad is to earn dividends.

The main business of operation is transportation, freight and passengers. Men of ability are given a free hand if they can increase the value of the shares, if they can add to freight and passenger receipts. Men of ability are not given the same free hand to operate and to maintain.

Equipment is expected always to be ready for operation and expense of maintenance be damned, operation is expected to carry traffic and expense be damned. A special train will be furnished on 15 minutes' notice, but a locomotive may wait three months for a deck plate, a shop must wait three years for a new boring mill that will shorten certain work one-half, and a roundhouse may wait three decades for decent lighting. Minor railroad officials have constantly to contend with similar inconsistencies. We are glad that the general passenger agent invites criticism of the quality of coffee served in the dining cars, but why should an offer to a general manager to submit confidential proof that $3,000,000 a year is being uselessly wasted be regarded as an insult?

A Wall Street house undertook to build a railroad in Alaska. They have beautiful surveys and traffic estimates, but made no provision for a railroad shop, although the locality was closed in by ice eight months in the year and the nearest machine shop was 2,300 miles away. They expected to operate over a mountain road with three per cent grades, using discarded New York L little anthracite burning tank locomotives.

I know a shop in New England that is the best managed concern in the world. I have had nothing to do with it. In organizing this shop its officials laid down two principles. The first was that the men must be given permanence of employment. The second was that if they got a good man they must hold on to him by enabling him to earn more than he could earn anywhere else in the neighborhood. They established their piece rate with these principles in view and without any reference to what piece rates were in neighboring shops. These rates were in some cases less and in some cases more. Competition, however, demanded that costs should not be higher than neighboring shops. On the other hand, the men must be allowed to earn more than in other shops. How were they to meet these two conditions? In every case where their rate was higher they analyzed that operation and found out how they could sub-divide it and give one part of the work to a skilled man and another part to an unskilled man, and they thus brought the cost down to that of their rivals without interfering with the principle that their men were to earn more.

Everything went on beautifully until the time of the panic.

No more orders. What were they to do? Lay off their men? That interfered with the principle of permanence of employment. Cut wages? That would not help, because they did not have any orders. They could not manufacture and stock up, because their product changed from year to year; moreover, money was just as scarce as orders. They said: This is a case where we capitalists, not the workers, must stand a theoretical loss; we have got to manufacture at less than cost, and we are willing to sacrifice $100,000 for the sake of the principle. They sent out salesmen and gathered in orders on the reduced price and filled up for five months' work. Then the Lord took care of His own, because nobody else being in the market raw materials fell in price so that they covered on raw materials and continued the whole time of the panic on full time, full wages and full profit.

MR. GILG: What prompted my question as to whether you include foreman and inspectors in the bonus, is the character of the work that is turned out in case they are included.

MR. EMERSON: We give each man a bonus for the average of his work. The standard time is set on what is reasonably possible for a job from floor to floor.

It is often assumed that there must be a great deal of red tape in applying these principles. Red tape cannot apply to principles but only to methods. Methods securing absoluate and perfect accuracy can be made very simple, simpler than the methods now in use. The methods of a bank in keeping your account are exceedingly simple, yet they are absolutely and immediately accurate and reliable. Typewriters, adding machines, slide rules, wage calculating machines, manifolding devices, automatic records and gauges, all serve to lessen red tape and clerical work.

In a general way I believe we can secure ten times as much information, we can secure absolute reliability and at once for about one-half the usual clerical force.

The labor efficiency of railroad maintenance is fully as high as in the general run of private concerns, nor is one much better than the other in the accuracy of cost accounting. Railroad shops as a rule pay slight attention to overhead charges and therefore imagine that they are turning work out cheaply when they are not. Commercial shops know that overhead charges are nearly the same in amount as direct labor expenses. Railroad shops often add only 5% to 10% for overhead, yet the same railroad will enter into a locomotive repair contract and indirectly agree to pay 100% overhead.

I know a commercial shop always willing to undertake railroad shop work at the railroad costs for material and labor, as it can generally save about 50% on material and 50% on labor. In a specific instance a large cast iron cylinder bushing cost in labor and material in the railroad shop over $90, cost the commercial shop less than $30.

Discipline is a principle, not a method. Disciplinarian is not synonomous with Martinet. Discipline does not mean severity, harshness, arbitrariness. It is but another name for order, for responsibility, for justice.

The Emerson efficiency reward differs from other bonus, premium or piece rate payments in one or more of the following particulars:

(1) The worker, under all circumstances, receives full wages per hour employed.

(2) It pays the worker at full rate for all the time he saves above 90% of standard.

(3) In addition, his wages per hour are increased 20% whenever he attains 100% average efficiency.

(4) An efficiency reward begins at one-half more than standard time.

(5) Efficiency depends on the average of all his work, not on any particular piece or day.

Attainment of high efficiency depends more on standardized conditions than it does on excessive individual effort. This applies to machines as well as to men.

COMPARISON OF TAXICAB OPERATIONS.

	New York	*London*
Street paving	Poor	Very good
Cab stands	Few	Many
First cost of cab	$2,700	$1,200
New York cab has to be heavier to stand the bad paving.		
Life of cab, in miles	40,000	140,000
Revenue miles per day	35	100

Because the cabs are lighter in London, cost of cab and tire maintenance are less, gasolene costs less per mile, the chaffeur receives three times as many tips, everybody is better off, all because the street paving, a condition, is of higher standard.

The fair deal requires that standards of operation shall be changed to meet general and special conditions. This is never difficult if the "fair deal" is the reason for the change.

Our system of record shows automatically those schedules that are too high and those that are too low and these can always be corrected without lessening the efficiency of any worker.

If through accidental causes a schedule proves too hard, a temporary schedule takes its place. I have changed a three-hour schedule to a temporary schedule of 20 hours when the steel castings were abnormally hard. Owing to the outcry of the man who could not come up to the regular schedule, the foreman took it up, the superintendent took it up, the purchasing agent took it up and the shop received thereafter normal castings. This illustrates the way a shop ought to run:

A finished casting is wanted by a locomotive.

The machine is there to finish the casting.

The machinist is there to serve the machine.

The foreman is there to serve the machinist.

The superintendent is there to serve the foreman.

The purchasing agent is there to serve the superintendent.

The supply plant is there to serve the purchasing agent.

Very often the flow is in the opposite direction. Supply houses sell to railroads what is not really needed and the long-suffering locomotive has to take the fol de rol and stand its useless cost as part of the maintenance cost per mile.

In efficiency work no time credit is given for defective work. If a worker takes five hours for a six-hour job and then has to take four more hours correcting bad work, his efficiency is not 120% but only 67%. His foreman loses out also. Inspectors are bonused on the flaws they find, not on the work they pass. Fitters are often bonused on the output of the men who follow them, riveters for example.

Efficiency does not always mean a greater output or a lower cost. It may mean better quality, fewer mistakes or the attainment of any standard.

MR. STARK: Referring to the wisdom and efficiency in the management of that manufacturing concern in New England that weathered the panic so successfully, suppose all of the manufacturing plants in the same line had a similar policy and were equally equipped and had followed the same course as the company referred to, would they not be in the same position as the employers today who are offering special inducements to attract men? Would there not be the same competition in disposing of the product or securing efficient labor, as is the case today?

MR. EMERSON: I hoped you would ask this question. If all manufacturers were wise enough to run their business as that plant was run we would have so wise a government that we would never have a panic.

Government efficiency is the wickedest inefficiency I know. It produces more widespread misery, yet is wholly unnecessary. The proper relation of the Individual, of the Corporation and of the State to humanity are perfectly plain. The individual corresponds to the day, the corporation to the month and the state to the year.

It is because the individual must spend today what he earned yesterday that it is necessary to have corporations which can wait months or even years for returns. It is because the corporation can last without earnings at most only a few years that we need a state which lasts forever, that can build a Panama Canal to cost $500,000,000.

Why should the Government not undertake these great works of secular improvement for which there is no immediate or urgent need, in time of depression, instead of stimulating the boom? Why is it not the chief duty of the Government to temper the wind to the shorn lamb, to act as a productive balance wheel in human affairs, and use its own great power to standardize production, cost of material, wages and interest rates?

One other criticism of a personal nature has been made by a noted Union Labor official.

Efficiency has been denounced as if its principles were my private property. Efficiency principles are not now and never can be on the defensive, because principles are universal and eternal.

I have never had any quarrel with Unionism. I have had close friends among Union leaders, and a great mistake is being made when they array the principle of Unionism against the principle of efficiency. The issue is of their seeking, not mine.

Private property is a principle, yet in case of disaster at sea it is set aside for another and temporarily more important principle and private right in property ceases to exist.

To make profits for their shareholders is a greater obligation for the officials of a corporation than to run an efficient but less profitable business.

Efficiency principles were not tried and found wanting as to efficiency in the shops of the American Locomotive Company. The principles accomplished exactly what they were expected to accomplish, and the more successful they were the more inexpedient they became, because, owing to railroad shortsightedness shop efficiency is not the principle through which locomotive builders can make the largest profit.

Because railroads have no maintenance and repair accounting worthy of the name, because they do not know about overhead expenses and the legitimate profit necessary for manufacturing concerns, because railroads consent, nay, insist on paying for the chaff as well as for the wheat, on paying for time wasted as well as for time worked, because railroads insist on deluding themselves that a 10% profit at low efficiency is a better contract than a higher profit at high efficiency, because railroads do not know how to insist on accurate shop accounting, it has proved inexpedient, would, in fact, be disastrous for the locomotive plants to eliminate wastes of both material, labor and factor that, with a profit added, are marketable for good hard cash. It is because it has been forced on them to market not only value but also waste, that the control of operation of the shops of the American Locomotive Company has been logically transferred from one of the most efficient shop operators in the world to the Vice-President in charge of the sales, who knows how to market what the shops produce, namely, wastes and value.

As the American Locomotive Company has not made public its efficiency records, it would be a breach of confidence for me to do so, although I have them in my possession. It is sufficient to say that the efficiency principles installed by the Vice-President, Mr. D. Van Alstyne

(1) Eliminated wastes.
(2) Reduced costs.
(3) Raised pay of workers.
(4) Expedited deliveries.
(5) Improved quality.
(6) Increased output.

It is because these vicious contracts make a day's work, irrespective of equivalent, the basis of charges; it is because certain unions demand a flat day's pay for their members irrespective of equivalent that a leader in unionism appears here tonight as the champion of the American Locomotive builders in their, I believe reluctant, disavowal of efficiency.

I am friendly to all of them. I can see just as plainly as they do that if you can market chaff at the price of wheat you don't want to buy or use a winnowing fan. My address is on the subject of railroad wastes, not on unionism or manufacturers' sales. Tonight I am calling attention to the fact that the railroads are buying chaff at the price of wheat and I call this a preventable waste.

It is the first duty of the officials of the great locomotive building plants to adopt sale policies which will earn most profits for their companies, profits badly needed after two years of severe depression.

From an efficiency point of view we all know that the objection to paying by the day is that the worker puts all the time he can on the job. He not only takes his own work easier, but more men have to be employed to accomplish the same result, and this helps out his brothers, his cousins and his uncles.

If I have a lawn to be mowed, a ditch to be dug, I am a fool to put it out on day's work, as this is to offer an incentive to loaf on the job with a sickle, instead of hustling over it with a horse mower. I call myself a fool for entering into this kind of a contract. What shall I call the railroads who purchase their labor and equipment on the basis of days worked?

When contracts are insisted on, under which inefficiency increases profits, and efficiency lessens them, it is folly to try to increase efficiency or to reduce inefficiency. If the railroads accept vague records of costs which no one can verify, it is folly to have accurate records by which every ten cents wasted can be traced.

Some railroads make their equipment and repair contracts on the basis of *Labor, Factor, Material, Profit.* In these contracts no mention is made of efficiency.

Labor is the work that can be directly charged to a contract. Factor, burden, overhead, surcharge, or whatever it may be called, covers the charges for power, rent, maintenance and supervision which cannot be specifically charged to each contract. Factor is usually charged as a per cent on direct labor charges. In some contracts the word "labor" includes the added percentage for factor.

I have seen many of these contracts, but not one in which labor is clearly defined. I have seen a shop sweeper's time charged up to the locomotives around which he swept, and a foreman's time similarly distributed. A large part of the factor items can, by a stretch of practice, be charged as direct labor. Let us assume that a railroad has entered into a contract to pay for its repairs on the basis of

(1) Wages paid.

(2) Seventy per cent general factor.

(3) Materials and

(4) Ten per cent profit.

One of the operations to be paid for may be the turning up of a pair of tires.

In the day work, day charge shop, the work can be given to a full machinist paid $0.30 an hour, with a helper assigned at $0.20 an hour. The tires are put into an old lathe and the machinist and lathe combine to make the job last 20 hours. The facilities are so poor that it takes part of the time of six other men to put the wheels in and out, and the foreman gives in addition one-tenth of his time to supervision, or he says he does. On the other hand, in a shop run on efficiency principles, including efficiency accounting, exactly the same job can be given to a handy man, using a modern tire lathe, with the work standardized at two hours from floor to floor, no helpers being required.

If two hours is 100% efficiency, then 20 hours is 10% efficiency. Both these records are from my actual experience in western shops:

Efficiency	100%	10%
Wages of handy man per hour	$0.25	
Efficiency reward 20%	0.05	
Total wages per hour	$0.30	
Wages of machinist		$0.30
Wages of helper		0.20
Distributed wages of foreman and other helpers		0.16
Total labor cost per hour	$0.30	$0.66
Specific factor for this operation	0.60	
General factor of plant without reference to operation 70%		0.46
Total hourly shop cost	$0.90	$1.12

Let us assume that a contract is on the basis of labor 70% factor and 10% profits, what would happen to the efficiency operation.

Time.	2 hours	20 hours
Wages per hour	$0.30	$0.66
Factor per hour 70%	0.21	0.46
Total hourly charge	$0.51	$1.12
Cost of job	$1.02	$22.40
Profit 10%	0.10	2.24
Amount charged railroad	$1.12	$24.64

Under the labor, factor and profit contract I am tied down to a charge of $1.12 in the efficiency shop, although the real factor may be much higher than 70%, but in the inefficient shop I can charge $24.64 for the same work.

I have seen charges as rank as these in locomotive repair work.

Assume, however, a more normal and usual condition.

COST OF EXACTLY SAME LOCOMOTIVE.

Efficiency of Shop.	100%	60%
Labor cost	$ 1,800	$ 3,000
Factor 70%	1,260	2,100
Material	9,000	10,000
Total cost	$12,060	$15,100
Fair profit	1,510	1,510
Selling price	$13,570	$16,610
Excess charge	3,040	
	$16,610	

In order that the building company may make its legitimate profit of $1,510 on the 10% profit contract, it has to decrease its own efficiency and make the railroad pay $3,040 too much.

It would be much better for the railroad to pay 20% profit on standardized efficiency and standardized accounting than to pay 10% on low efficiency and unstandardized accounting.

Competition is not the remedy. There are only 6,000 locomotives required annually in the United States. The two big companies will divide the business and they will maintain about the same efficiency, no higher than the railroads demand.

It is violating no confidence to say that under efficiency principles as installed by Mr. D. Van Alstyne in the shops of the American Locomotive Company, labor and factor costs decreased. Since this company has been forced to abandon these principles in favor of sale and profit principles, costs have increased. Who pays the increase? I do not blame the American Locomotive Company nor am I worried about the value of efficiency principles. I simply marvel that the railroads are willing to stand the wastes and to pay for them.

In the last 10 years the principles of shop management, of shop accounting and of shop efficiency have been developed so as to permit absolutely accurate and predetermined statements of cost on the basis of definite efficiencies and reliable specific factors.

Contracts on these lines are fairer to both builder and purchaser and would ultimately reduce costs, yet add to profits, the gain to both coming from the elimination of needless wastes.

MR. S. C. MASON: I think this meeting will go down to history in the annals of the Railway Club of Pittsburgh as one of the most interesting meetings we have ever held. The discussion that has been provoked here tonight has been most interesting. I think we owe a vote of thanks to Mr. Emerson for his paper and I move you that a vote of thanks of the Club be extended to Mr. Emerson.

The motion was duly seconded and carried by unanimous vote.

ON MOTION, Adjourned.

In Memoriam.

E. J. RANDALL

WHEREAS, A beloved member of the Railway Club of Pittsburgh, Mr. E. J. Randall, Engineer Maintenance of Way, of the Union Railroad, has been called from our midst to the higher life above; therefore, be it

RESOLVED, That the Railway Club of Pittsburgh has lost a valuable member, whose place cannot be filled.

That his family has lost a kind and loving husband; his company the services of a skilled and devoted officer, and the community an able, high minded and influential citizen.

"His life was gentle, and the elements so mixed in him that nature might stand up and say to all the world, 'This was a man!' "

RESOLVED, That these resolutions be spread upon the minutes of this Club, and an engrossed copy be presented to his family.

Also that they be published in the Official Proceedings of this Club and that copies be furnished to the daily papers and railway journals.

F. R. McFeatters,
Edwin F. Wendt,
R. A. Clark,
Committee.

ESTABLISHED 1891

EDWARD KERR, President

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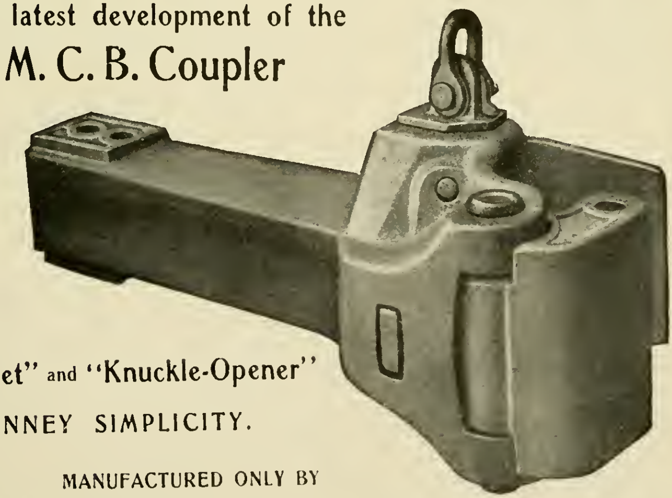

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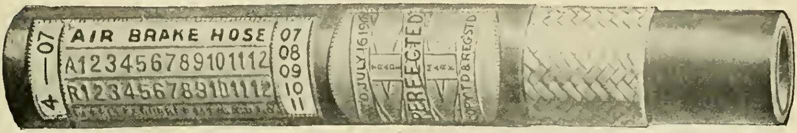

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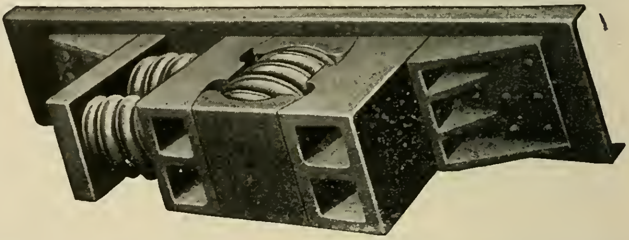

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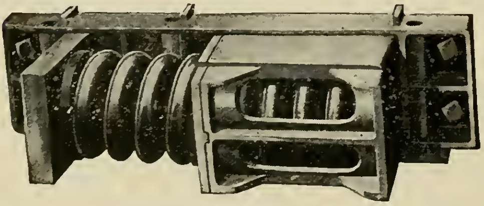

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Testimony From the Actual Users (7*)

❡ From time to time we have published statements regarding merits of the "MODERN BOILER TUBE," i. e., the steel tube.

❡ In the last analysis, the success of any article must depend upon its own specific merits as evidenced by the experience of actual users.

❡ At the 1909 Convention of the International Master Boiler Makers' Association, held in Louisville, Ky., there was a discussion of the report of the Committee on Boiler Flues, and we quote from the published proceedings the remarks of a representative of an Eastern Railroad:

> "In the last eight years we have bought nothing but steel tubes. We haul the biggest tonnage in the United States for a small road. We have engines carrying 125 pounds pressure that use steel tubes. We weld them on to anything we have got. We have got any amount of old iron tubes; some of them have been welded fifteen times, and we have steel ends on them today. As a general thing on the .... road they use nothing but steel tubes and they buy nothing else for ends but steel."

❡ It will be noted this railroad has used the steel boiler tube for the last eight years, and it is by no means an experiment with this road, neither was it adopted lightly nor without full consideration.

❡ We formerly manufactured both iron and steel boiler tubes, but we were led to believe by our own experience (and the experience of others served to confirm this belief) that the steel boiler tube was the more economical tube, hence we ceased manufacturing iron tubes, and are now devoting our attention to the making of the "MODERN BOILER TUBE," i. e., the steel tube.

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*This is the seventh in a series of announcements regarding "Testimony from the Actual Users." Others have appeared in previous issues and will appear in later issues of this journal.

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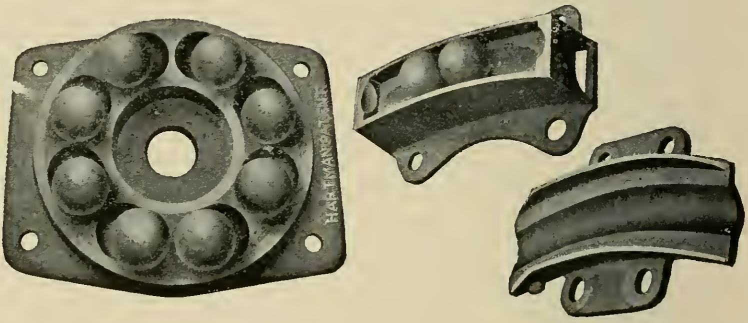

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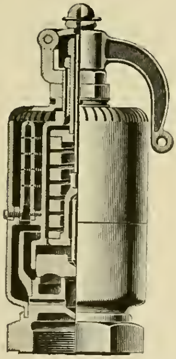

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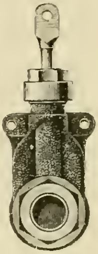

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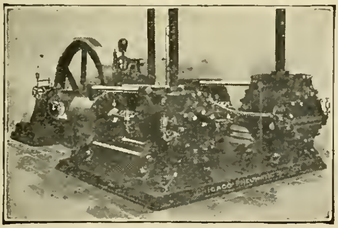

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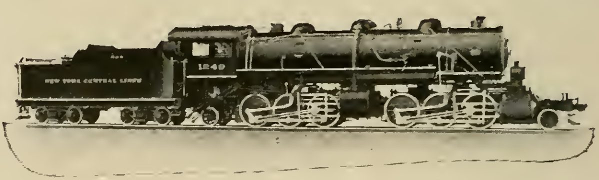

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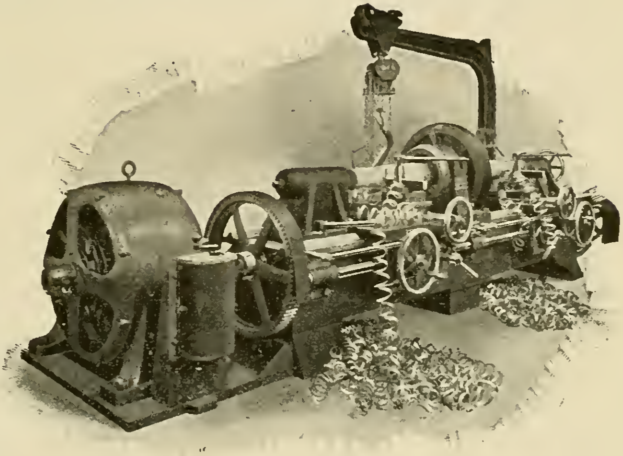

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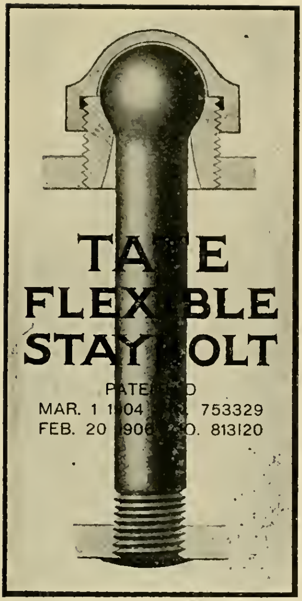

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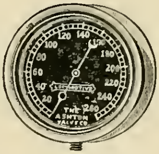

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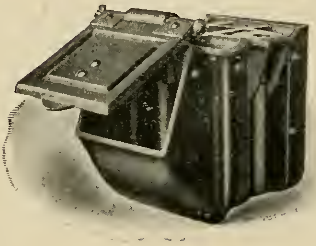

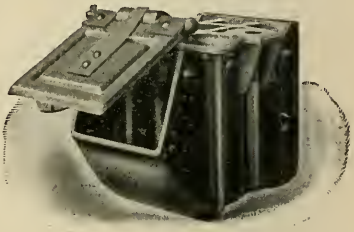

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING,
MARCH 25th, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

The following gentlemen registered:

MEMBERS.

Ackenheil, J. D.
Alleman, C. W.
Allison, John
Amsbary, D. H.
Bailey, Robert J.
Barth, J. W.
Bealor, B. G.
Beltz, J. D.
Bishop, J. B.
Boyer, Charles E.
Brownscombe, G. J.
Chapin, E. S.
Chittenden, A. D.
Conway, J. D.
Coulter, A. F.
Courson, C. L.
Crouch, A. W.
Deckman, E. J.
Delaplane, J. L.
Dickinson, F. W.
Dobson, O. C.
Dyer, Joseph
Falkenstein, W. H.
Gies, Geo. E.
Gilg, Henry F.
Good, H. J.
Griffey, J. W.
Gulick, H.
Haas, Ben.
Halliwell, C. J.
Hindman, S. M.
Howe, W. C.
Hunter, H. S.
Jenney, Jacob
Kennedy, Jas.
Kinter, D. H.
Kleine, R. L.
Knight, E. A.
Knox, Wm. J.
Koch, Felix
Krause, Julius
Kull, W. A.
LaMar, A.
Lehr, H. W.
Leonard, Jas., Jr.
Long, R. M.
Loudenbeck, H. C.
Lynn, Samuel
Mackenzie, R. H.
Matthews, John A.
McFeatters, F. R.
McInturff, C. A.
McNulty, F. M.
Pitzer, Edwin H.
Porter, H. V.
Rauch, T. T.
Redding, D. J.
Riddell, W. J.
Rupp, R. D.
Russom, T. H.
Ryan, W. F.
Schaffer, R. H.
Shannon, Chas.
Sitterly, W. H.
Slemmer, W. M.
Slocum, R. L.
Smith, D. W.
Stark, F. H.
Stewart, C. A.
Stucki, A.
Swann, J. B.
Sweeley, G. P.
Swigart, W. R.
Taylor, H. G.
Warfel, J. A.
Warne, J. C.

VISITORS.

Baldwin, G. C.
Barnes, P. H.
Buffum, F. S.
Campbell, Argyle
Chamberlain, Harold B.
Cooley, Roswell P.

Flinn, R. H.
Gabler, R. B.
Hettler, R. C.
Hoen, G. L.
Hogarth, Wm.
Jones, J. G.
Johnson, Fred G.
Keller, W. L.
Kuenzel, Oscar
Lauglin, J. A.
Mowry, R. B.
Orr, A. M.
Publes, W. L.
Reeve, F. J.
Smith, Sion B.
Stark, J. L.
Walter, P. F.

The reading of the minutes of the last meeting was dispensed with, they being in the hands of the printer.

The Secretary read the following list of applications for membership:

Baker, B. R., Rep., Gulf Refining Co., Frick Building, Pittsburgh, Pa. Proposed by H. G. Taylor.

Beatty, E. A., Foreman, American Locomotive Co., 1429 Woodlawn Ave., North Side, Pittsburgh, Pa. Proposed by B. L. Tamkins.

Borland, W. P., Asst. Treas. and Asst. Secy., Rodman Chemical Co., East Pittsburgh, Pa. Proposed by A. W. Fullerton.

Dean, A. E., Taylor & Dean, Twenty-fifth St. and Penn Ave., Pittsburgh, Pa. Proposed by Wm. C. Shuck.

Downs, Joseph J., Train Dispatcher, B. & O. R. R., 67 Hazelwood Ave., Pittsburgh, Pa. Proposed by J. W. Griffey.

Harner, A. J., Traveling Engineer, Monon. Div., P. R. R., West Brownsville, Pa. Proposed by H. G. Scheck.

Kennedy, P. S., Manager, Jos. T. Ryerson & Son, 1572 Frick Annex, Pittsburgh, Pa. Proposed by Wm. C. Shuck.

Lewis, A. J., Car Distributer, Monongahela R. R. Co., South Brownsville, Pa. Proposed by W. B. Sager.

McElheny, M. L., Train Dispatcher, B. & O. R. R., 427 Hallett Place, Bellevue, Pa. Proposed by J. W. Griffey.

Radcliff, C. R., Traveling Fireman, B. & O. R. R., 214 Towbridge St., Pittsburgh, Pa. Proposed by J. W. Griffey.

Robinson, J. R., Asst. to Manager, American Locomotive Co., 1108 Bidwell St., North Side, Pittsburgh, Pa. Proposed by B. L. Tamkins.

Stoddart, W. G., Order Clerk, H. K. Porter Co., 1405 Woodland Ave., North Side, Pittsburgh, Pa. Proposed by B. L. Tamkins.

Tunstall, Wm., Master Carpenter, Union R. R., 330 East Eleventh Ave., Homestead, Pa. Proposed by F. R. McFeatters.

Yohe, J. K., Jr., Night Chief Dispatcher, B. & O. R. R., Pittsburgh, Pa. Proposed by J. W. Griffey.

PRESIDENT: These names will be submitted to the Executive Committee and upon their approval the gentlemen will become members.

The Secretary announced the death of Mr. William W. Colburn, of the Universal Portland Cement Company, as the result of an accident, whereupon the President appointed Messrs. J. D. Conway, R. L. Slocum and H. E. Swartz a committee to draft suitable memorial resolutions.

PRESIDENT: If there is no other business, we will proceed with the paper of the evening, the Annual Report of the Standing Committtee on Revision of M. C. B. Rules of Interchange. This is the occasion when we annually give everybody a chance to work, and we want each one of you to feel free, in fact, feel it a duty to take part in the discussion. If anyone has anything to offer to improve the Rules of Interchange, now is the accepted time to bring it forward.

REPORT OF STANDING COMMITTEE ON REVISION OF M. C. B. RULES OF INTERCHANGE.

Mr. President and Gentlemen: The usual notice was sent out to the members of the Railway Club of Pittsburgh to forward to the Chairman of your Standing Committee on M. C. B. Rules of Interchange any suggestions for changes in these rules, in answer to which we received one reply—from Mr. E. J. Leonard, of the United Coal Company—aside from the answers made by the members of the committee. All of these suggestions were carefully considered and we give below the changes or additions, which are unanimously recommended by your committee.

Your committee very much appreciates the arrangements made for their stay while in Pittsburgh considering the rules and desire to express their appreciation and thanks for the entertainment provided:

TITLE PAGE.

Change to read: "Governing the condition of, repairs to and *loading of* freight cars * * *."

This change is suggested in order to bring about uniformity in loading on cars offered in interchange which will expedite the movement of cars through interchange points and avoid present-day delays and resulting expense from adjusting loads on account of not conforming to M. C. B. Rules for Loading. These rules are now a Standard of the M. C. B. Association and are in charge of a Standing Committee which will insure the Loading Rules being kept up to date, similarly to the Rules of Interchange.

PAGE 2—Heading Under Code of Rules.

Change to read: "Governing the condition of, repairs to and *loading* of freight cars for the interchange of traffic."

To conform to change made in title page.

PAGE 2—Preface. Second Paragraph.

Change to read: "Railroad Companies handling cars are responsible for damage done to any car by unfair usage, derailment or accident, *or for defects specially provided for in the rules*, and for improper repairs made by them; *also for improper loading;* and they must make proper repairs or *adjustment of lading* at their own expense, or issue defect card covering such damage or improper repairs."

To conform to changes made in title page to include loading of cars and also to cover defects in cars and trucks for which the delivering company is now held responsible and which is not covered in the preface.

PAGE 2—Preface. Third Paragraph.

All inspection of freight cars for interchange will be made in accordance with the following rules *and the M. C. B. Rules for Loading.*

To conform to change made in title page.

RULE NO. 3.

Add after the word "exist" in eighth line the following:

"And in the case of journal boxes and contained parts the location on side of car." Also at the end of paragraph the following: *"Facing the 'A' end of car the journal box on the outside wheel to the right shall be known as A R* 1 *and the journal box on the inside wheel to the right as A R* 2, *on the left side the journal box on the outside wheel as A L* 1 *and the inside wheel as A L* 2. *In the same manner facing the 'B' end of the car the outside and inside journal boxes on the right side shall be known as B R* 1 *and B R* 2, *respectively, and on the left side as B L* 1 *and B L* 2."

This suggestion for modification in the rule is in line with Arbitration Decision providing that not more than one journal bearing can be charged applied to same journal of a car during any one trip. While a recommendation of this kind was presented last year and did not receive the approval of the Arbitration Committee it is again submitted for further consideration, inasmuch as a large number of bills are being returned and considerable correspondence entailed which could be avoided if the location of the journal box and contained parts were specified in the rules.

RULE NO. 4.

Add after "29" in last line "33."

To provide for the delivering company responsibility for wrong air brake hose.

RULE NO. 7.

Change first paragraph to read: "Shelled out; wheels with defective treads on account of cracks or shelling out spots 2½ *inches or over*, or so numerous as to endanger the safety of the wheel."

To make the wording of this rule consistent with Rule 19 and gauge dimensions. This change would conform to present practice.

RULE NO. 9.

Change to read: "Worn through chill: when the worn spot is 2½ *inches or over in length*. Care must be taken to distinguish this defect from flat spots caused by sliding wheels."

To make wording consistent with gauge dimensions and conform to practice in using gauge.

RULE NO. 10.

Change to read: "*Worn flange*, cast wheels: *Wheels* under cars of less than 80,000 pounds capacity, with flanges having flat vertical surfaces extending 1 *inch or more* from tread, or flange 15-16 inch thick or less, gauged at a point ⅜ inch above tread. Wheels under cars of 80,000 pounds capacity or over, with flanges having flat vertical surfaces extending ⅞ *inch or more* from tread, or flange 1 inch thick or less, gauged at a point ⅜ inch above tread. (See Figs. 4 and 4-a)."

Worn flange, steel and steel tired wheels: Wheels with flanges having flat vertical surfaces extending 1 *inch or more* from tread, or flange 15-16 inch thick or less. (See Figs. 4 and 4-a.)"

The above changes are suggested so that the wording of the rule will be consistent with gauge dimensions, and also more clearly define the rule as it relates to cast iron or steel wheels.

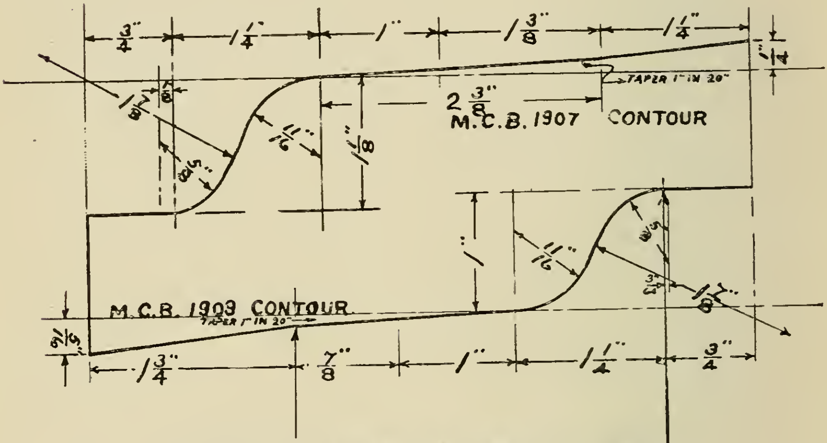
RULE NO. 11.

Change last line of this rule to read: "*Standards* of 1907 *and* 1909. (See Fig. 2-a.)"

Standard for wheel tread adopted in 1909 has been added.

RULE NO. 12.

We should have some suitable method or gauge to determine when a tread is worn sufficiently to condemn the wheel. Our present rule leaves the matter entirely to the judgment of inspectors, with the result that in some cases wheels are allowed to run until they fail in service, whereas in other instances good wheels fit for further service are being condemned. We would recommend that this question be referred to the proper committee of the Master Car Builders' Association with instructions to present a suitable gauge for this purpose. As a suggestion along these lines we show a cut of a gauge used with good results by one of the trunk lines for condemning worn tread wheels, the following requirement being observed in connection with the use of the gauge: "Tread worn hollow: if hollow spot is ¼ inch or more in depth, wheel is unsafe and must be removed." After the proper gauge is determined upon we would recommend that Rule 12 be changed to conform thereto.



GAUCE TO REST ON WHEEL AT THESE TWO POINTS.
WHEEL IS CONDEMED WHEN TREAD IS WORN DOWN AT ANY POINT
$\frac{1}{4}$" BELOW GAUGE. $\frac{1}{16}$" STEEL.

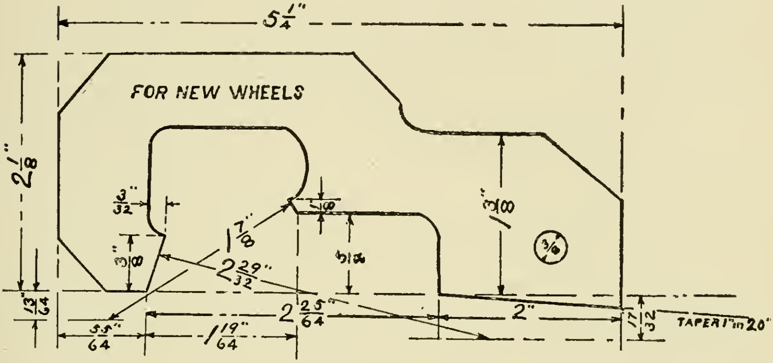
RULES NOS. 18 AND 20.

Combine Rule No. 18 with Rule No. 20 and make the chipped flange a Delivering Company's responsibility in all cases.

While this recommendation was presented last year and did not receive favorable consideration, we believe that attention should again be directed to this rule with a view of having chipped flanges placed under Delivering Company's responsibility only. Nearly all flanges that are chipped extend past center of flange, which makes it difficult if not impossible in some instances to determine under the present rules whether the defect is an Owner's or Delivering Company's defect and as such chipping is generally the result of track conditions the handling road should be held responsible.

PAGE 9. FIGURE 2-a.

Maximum flange thickness gauge shown in this figure and M. C. B. circular dated January 1, 1910, relating to same should be changed in accordance with the following cut for the reason that gauge cannot be laid out as per circular. The dimensions given on sketch are based on the standard flange dimensions.



MAXIMUM FLANGE THICKNESS GAUGE.
For all wheels cast after January 1, 1908.
FIG. 2-A.

PAGE 10. FIGURE 4.

Change notes under this figure to read: "For *cast* wheels under cars of less than 80,000 pounds capacity, and *all forged* steel or steel tired wheels with flanges 15-16 inch thick or less; *cast wheels under cars of* 80,000 pounds capacity or over, with flanges 1 *inch thick or less.*"

Re-worded to make note clear to inspectors and to conform to change recommended in Rule No. 10.

PAGE 11. FIGURE 4-a.

Change note under this figure to read: "For *cast* wheels under cars of less than 80,000 pounds capacity, and *all forged* steel or steel tired wheels 1 inch *or more* from tread; for *cast wheels under cars* of 80,000 pounds capacity or over, ⅞ inch *or more* from tread.

For the same reasons given under Figure 4.

PAGE 14. FIGURE 6-a.

The dimensions of 4′-5-3-32″ to be changed to 4′-5-5-32″, due to not mounting more than one wheel with maximum flange thickness on same axle in accordance with Rule 66.

This will reduce guard rail blows on back of flanges.

RULE NO. 30.

Change to read: "Damage to interior portion of cylinder or triple valve, leaky pipes account of seams, air hose burst from air pressure, torn air hose and defective, missing or worn-out parts of brakes *which have failed under fair usage not elsewhere provided for.*

Latter portion of this rule omitted to more clearly indicate owner's responsibility.

RULE NO. 33.

Change to read: "Cars equipped with air brake hose other than 1⅜-inch M. C. B. standard, and so branded (See Fig. 7), except cars equipped with 1¼-inch M. C. B. standard hose, and so branded, manufactured and applied prior to September 1, 1909, will be accepted in interchange. Delivering company responsible.

NOTE: If date of application is not cut off from badge, date of manufacture will be accepted as date of application.

To agree with Arbitration Decision 799. Figure No. 7 should be included in the rules showing a cut of the Standard 1⅜" M. C. B. Label for Air Brake Hose now shown in the 1909 M. C. B. Proceedings, page 598, and sheet M. C. B. 18.

RULE NO. 34.

Add new rule: "Burst or torn air hose, burst or leaky pipes account of seams, or missing material on cars offered in interchange. (Delivering Company responsible.)"

The above transposition from the latter part of Rule No. 30 is desirable in order to have the rules relating to delivering company's responsible together.

RULE NO. 37.

Change to read: "All freight cars offered in interchange must be equipped with air brakes and M. C. B. Standard 1¼ inch train line and angle cock.

To provide for the uniform equipment of all cars and that the air brakes will be operative when placed in any part of the train.

RULE NO. 38.

Add a new paragraph after the first paragraph reading as follows: "Steel cars offered in interchange not equipped with card boards for repair and defect cards. (Owners responsible.)"

A number of steel cars are running minus the card board for applying the repair and defect cards, and as Rule No. 5 provides that all cars should be equipped with a card board the owners should be responsible for not applying these card boards when the cars are built.

RULE NO. 40.

Add in second line after the words "Bad order" the following: "(which have not been damaged by unfair usage.)"

Steps, ladders, running boards or handholds damaged by cars being cornered or other unfair usage should not be charged against car owners.

RULE NO. 47.

Insert "33" after "29" in line four.

Wrong air brake hose has been made a delivering company's responsibility.

RULE NO. 49.

Change to read: "Damage to coupler body accompanied by damage to two draft timbers, or substitutes, or end sill."

Combined front and back coupler stops have been omitted as some of these stops fail under fair usage on account of their weak construction, whereas, when these stops are properly designed they do not break in ordinary handling, but if broken there are sufficient other details damaged to make it a combination defect. As they are concealed the defective stops cannot be discovered until taken down and, therefore, should not enter into combination. It is a frequent condition to find one draft timber defective on cars in connection with a broken coupler in ordinary service, for which reason we believe the combinations should be extended to take in two draft timbers or their substitutes.

RULE NO. 50.

Would recommend that this rule be omitted from the rules for the reason that where the coupler yoke is broken it has caused the damage to end sills and draft timbers, and the coupler yoke breaking, in the majority of cases, is due to defects in the same and fails under fair usage. The trouble in these cases is that the defects are concealed, and it is very difficult to discover them by inspection.

RULE NO. 51.

Omit this rule for reasons given under Rule No. 49.

RULE NO. 52.

Change to read: "Two damaged draft timbers, or substitutes accompanied by damage to either coupler body or to end sill."

For the same reasons given under Rules 49 and 50.

RULE NO. 53.

Change to read: "Damaged end sill, accompanied by damage to either coupler body, two draft timbers or substitutes, or one longitudinal sill."

For the same reasons given under Rules 49 and 50.

RULE NO. 56.

First note relating to coupler should be omitted and add the word "body" to Rules 49, 52 and 53.

Third note relating to missing coupler: Omit "and attachments" for the reasons given under Rule 50.

Last note relating to combined front and back coupler stops to be omitted for reasons given under Rule 49.

RULE NO. 59.

Your committee recommends that the question, as to which beams on the market and in common use meet the M. C. B. specifications and tests for either No. 1 or No. 2 brake beams, be submitted to the proper committee of the Master Car Builders' Association, with instructions to make tests to determine which beams come under No. 1 and No. 2 specifications, and publish the same in the Proceedings, so that shops and inspection points in making repairs and changes in brake beams can be governed accordingly in applying beams of the proper strength. Such beams which meet the specifications No. 1 and No. 2 be so marked that they can be readily identified. When this has been done the Arbitration Committee should fix a standard price to be charged for No. 1 and No. 2 beams.

RULE NO. 63.

First paragraph to be changed to read as follows: "When M. C. B. couplers *or parts of same,* metal brake beams, wheels or axles are replaced, it must be plainly stated on the repair card whether the material is new or second-hand.

For the reason that Rule 102 provides that second-hand coupler parts shall be charged at 75% of value new, while present Rule 63 does not cover locks or knuckle pins. The information should be given irrespective as to whether it is charged to car owner or not.

Second paragraph, sixth line, after the word "shank," insert "and butt."

In 1907 the M. C. B. Association adopted as standard coupler butt dimensions of 6½" and 9⅛", the latter to be used with friction draft gear, but under the present reading of Rule 63, it is possible to omit mention of the application of a 6½" butt coupler to friction draft gear cars, this size butt necessitating liners, which aside from being improper repairs, is also very bad practice, never allowing the yoke lips to fit over the butt, being always a heavy source of expence on all cars so equipped, due to rapid shearing of rivets. If it is made mandatory to show size of the coupler butt on repair cards it would result in materially reducing the cost of maintenance of yoke rivets, which in itself would be a step in the right direction.

RULE NO. 64.

Add as follows: "When bill is to be rendered, the height of car before and after altering must be shown on repair card.

This to instruct repairmen as to necessity of showing this information in accordance with Rule No. 105.

RULE NO. 66.

Page 33, the word "new" in first line to be cut out.

Maximum flange wheels may occur in secondhand wheels and two maximum flanges should in no case be mounted on the same axle.

RULE NO. 71.

Change to read: "In replacing air brake hose on foreign cars for which bills are made, new 1⅜ *inch* M. C. B. standard hose, and so labeled, must be used.

To be consistent with other rules on this subject.

RULE NO. 75.

Change to read: "When two or more cars chained together *with switch chains and couplers blocked out with metal spacing blocks* are delivered at an interchange point, the receiving road shall deliver to the delivering road at the time an equivalent number of switch chains *and metal spacing blocks* of the same size as the chains *and blocks* used on the cars delivered, or in lieu thereof furnish a defect card for such chains *and metal spacing blocks.*

We have at different times made this recommendation to the Arbitration Committee, but it did not meet with approval. Your committee is in receipt of a telegram from the chairman of the Committee on M. C. B. Rules for Loading Material that they will recommend the use of metal spacing blocks. These metal spacing blocks are now a standard of the M. C. B. Association and since the advent of the steel car, service has demonstrated that the wooden block with and without the metal liners crush resulting in the load on the car shifting, due to the lost motion between the horn of the coupler and the end sill, necessitating shopping of the cars and adjusting load. These metal spacing blocks are expensive and the roads applying the same and complying with the Master Car Builders' standards in this respect should be protected in interchange, as the roads receiving the loads obtain the advantage from the use of these metal spacing blocks. The receiving roads are at no expense when they turn over these metal spacing blocks to the delivering road, but they are penalized for their failure to do so under the proposed rule.

RULE NO. 77.

Change to read as follows: "The repair card shall be 3½x8 inches, made in triplicate, to be known as Repair Card, Billing Repair Card, and Record Repair Card. The Repair Card to be tacked on car shall be of cardboard, printed on both sides in black ink, and *items of repairs made and why made* shall be filled in on both sides in writing, one side to be filled in with ink or black indelible pencil. The Billing Repair Card, etc."

To provide for the information on these cards being filled in in writing at the time the repairs are made and to avoid a practice which is coming into pretty general use of writing up the items of repairs and subsequently stamping the Billing Cards to designate whether material is new or second-hand. A practice of this kind is liable to lead to irregularities.

RULE NO. 89.

Last year attention was directed to Rule 89 and the Arbitration Committee recommended that the question of an average credit price for cast wheels based on the number of wheels withdrawn from cars and scrapped; also the question of proper charges and credits for service metal on steel and steel tired wheels applied and removed from service be referred to a special committee to be appointed to study these matters and report next year. It would appear that this was not done and, therefore, your committee renews their suggestion in regard to average credit prices for cast iron wheels and append for the consideration of the Arbitration Committee a set of rules covering an equitable plan for taking care of the service metal on forged steel and steel tired wheels. While we appreciate that this matter is complicated, steel wheels are coming into more general use and, therefore, the rules should be amended to cover same. This question should be submitted to a committee to report upon the same as recommended by the Arbitration Committee.

Change rate per 1-16 inch thickness of tread or tire from $1.50 to $1.00, which will more nearly approximate the value of the loss of service metal.

Add the following:

A. Steel or steel tired wheels having defects for which owners are not responsible and repairs are made by the road responsible for the defect, the billing repair card and the repair card applied to the car must show repairs made and why made and be marked "No Bill" to indicate that no charge will be made for removal, turning and replacing of wheels. The billing repair card must show the following additional information:

1. Actual flange thickness and thickness of tire before and after machining of both wheels on the same axle, whether one or both wheels are damaged.
2. Amount of service metal in each wheel removed.
3. Actual flange thickness and service metal in each wheel, if other wheels than those removed are applied.

NOTE: The service metal in all wheels must be based on a full flange per 1909 Recommended Practice, "Wheel Tread and Flange for Steel and Steel Tired Wheels."

The gauging of flanges must always be made at a point ⅝ inch above tread of wheel.

The information covered by items 1, 2 and 3 under paragraph "A" will be owner's authority for billing the road responsible for the defect in case there is a loss of service metal, and for the owners to authorize the road making the repairs, to bill them for additional service metal, if any, in the wheels applied.

B. When defect cards are issued for damage to steel or steel tired wheels and repairs are made by owners, the information covered by items 1 and 2 under paragraph "A" must be shown on a billing repair card to accompany the bill.

This information in connection with the defect card will be owners' authority for billing against tthe road responsible for the labor in removing, turning, replacing wheels and loss in service metal, if any.

C. When defect cards are issued for damage to steel or steel tired wheels and repairs are made by other than owners, the billing repair card must show the information covered by items 1, 2 and 3 under paragraph "A" and the billing repair card and defect card must accompany the bill against the owner for the labor only of removal, turning and replacing of wheels.

The information on repair cards and the defect card will be the owner's authority for billing the road responsible, for the labor removing, turning, replacing wheels and loss in service metal, if any; also information for the owners to authorize the repairing road to bill them for additional service metal that may be in the wheels applied.

D. Additional service metal to be charged against the owners at the rate of $1.00 per 1-16 inch thickness of tread or tire.

RULE NO. 94.

Add the following:

"Brake key bolt renewed (when lever or connection is applied), net 3c

At the present time there is no uniformity in charges for doing this work. Some roads add a labor charge for applying the key bolt, which should not be allowed when lever or connection is applied, as the labor for applying lever or connection should cover the labor applying the key bolt.

Brake key bolt and cotter renewed, net............ 9c

At present it is the practice to make a material and labor charge for applying brake key bolt and cotter, and as this is a common item of repair one charge should cover the work. The above price will be similar to the present price of 2c for spring cotter pins for key bolts, applied.

RULE NO. 96.

Add: "Metal brake beams" after the words "M. C. B. couplers" in fifth line.

Metal brake beams should be treated the same as M. C. B. couplers in regard to scrap material.

RULE NO. 98.

Add to end of second paragraph: "The substitution of entirely different car numbers is not permitted."

While it is conceded that mistakes may be made in taking down or in the transposition of car numbers for which correction should be allowed to be made, the practice of substituting entirely different car numbers for those originally billed should not be allowed.

RULE NO. 106.

Add: Brake connection applied, ½ hour, 12 cents.

Brake connection repaired and replaced, 1 hour, 24 cents.

These are common items of repairs and as there are variations in the charges a stated price for labor should be given.

Posts, corner, door, end or side, each removed when associated with renewal of *side sills*, side or end plates.

Side sills have been added on account of contributing to the replacement of post.

Under the heading of "Sills" change the word "replaced" to "renewed" to avoid confusion with sills replaced but not renewed.

Last item in table on page 59 change to read: "When necessary to remove load at one end of car to make repairs."

At the present time this item of labor does not cover all of the cases where it is necessary to remove load to make repairs.

RULE NO. 111.

Change first line of second paragraph to read: "When one or more carrier bolts *over* 4 *inches long* or re-."

To be consistent with the labor charges given in Rule 106 for applying carrier iron bolts 4 inches long or less, in connection with coupler.

RULE NO. 112.

Page 67, add new item: "Triple cylinder bushing reground or refitted, $1.12."

No price is given to cover this item and this repair is necessary on account of age of triple valves. Price is standard charged for this repair by Westinghouse Air Brake Company.

RULE NO. 113.

Page 69, under heading of steel, add "Flat car, wooden floor, metal underframe, 8 wheels, 30 tons capacity, 40 feet over end sills, $500.00."

No price given for this class of car.

GENERAL.

We would recommend to the Arbitration Committee that a committee be appointed to investigate the defects on steel cars and composite cars with a view of formulating rules of owners and delivering companies' responsibility on cars. At the present time the rules only cover cars of wooden construction and serious questions have arisen at interchange points and at shops as to the responsibility for defects on such cars.

In order to obtain information on this subject and inasmuch as steel cars are so commonly used in the Pittsburgh District, it was thought desirable that your Standing Committee should report upon this subject at the club meeting next year.

With this end in view it is suggested that the following sub-committee be appointed to formulate a list of questions for the purpose of incorporating in the M. C. B. Rules of Interchange, rules governing the repairs to steel cars and owners and delivering companies' responsibility for such repairs. This sub-committee to present their recommendations within a period of three months and submit the same to the committee of the whole for consideration at the call of the chairman of the committee:

F. W. Dickinson,
S. Lynn,
J. Krause,
F. H. Stark,
S. A. Cromwell,
R. L. Kleine (*Chairman.*)

That the Arbitration Committee revise their edition of arbitration decisions in order to bring them up to date to meet conditions under present M. C. B. Rules.

Respectfully submitted:

G. E. Carson,
New York Central Lines.

S. A. Cromwell,
Baltimore & Ohio Railroad.

F. W. Dickinson,
Bessemer & Lake Erie Railroad.

G. N. Dow,
New York Central Lines.

W. J. Knox,
Buffalo, Rochester & Pittsburgh R. R.

J. Krause,
Pennsylvania Railroad.

A. La Mar,
Pittsburgh, Fort Wayne & Chicago Railway.

S. Lynn,
Pittsburgh and Lake Erie Railroad.

F. M. McNulty,
Monongahela Connecting Railroad.

J. B. Swann,
Pittsburgh, Cincinnati, Chicago & St. Louis Railway.

F. H. Stark,
Montour Railroad.

R. L. Kleine (*Chairman*),
Pennsylvania Railroad Lines East of Pittsburgh.

PRESIDENT: I think we will take this up by calling for a discussion on each rule in the M. C. B. Interchange Book, and if any member has anything to offer I wish he would present it as the rule is called. Mr. R. L. Kleine, the Chairman, will speak for the Committee.

The various rules were called, and the recommendations of the Committee were presented and adopted without discussion, except as hereinafter set forth.

Page 2, preface, third paragraph:

MR. JOS. DYER: The heading of the Code of Rules reads that they govern the condition of and repairs to freight cars and has nothing to do with their loading. If the loading rules were embodied with the M. C. B. Rules governing the interchange of cars, it might be well to make this addition. But inasmuch as the code of rules governing the interchange of freight cars has nothing to do with their loading, I do not think it would be well to embody the change recommended.

MR. R. L. KLEINE: I might say that the Rules of Interchange were adopted for the purpose of facilitating the interchange of cars. The Loading Committee of the Master Car Builders' Association is now a standing committee, and due to cars not being loaded in accordance with M. C. B. standards, more or less trouble is experienced at interchange points on account of the rejection of cars, and I can see no reason why we should not include the loading rules in the interchange rules, as they are both for one and the same purpose, and that is to facilitate the movement of cars through interchange.

PRESIDENT: Your idea would be to combine the two sets of rules?

MR. KLEINE: That can be done or they can be kept separate, as they are now.

MR. DYER: This suggested change states that the Interchange code of rules governs the loading.

PRESIDENT: Your idea would be to make it standard?

MR. KLEINE: That is the reason we want it incorporated into these rules. Unless we mention it on the title page and refer to it in the body of the rules, the Interchange rules would not govern the loading. Your committee recommends that we incorporate rules for loading in the interchange rules, so as to cover the matter.

MR. DYER: Wouldn't it be well to make the suggestion to embody the rules for loading cars in the M. C. B. Rules governing the interchange of cars?

MR. KLEINE: We discussed that very carefully at the meeting, but thought it best to leave it to the Arbitration Committee as to whether they wanted to make one book governing loading and interchange rules, or keep them as separate volumes.

PRESIDENT: You do want it to be understood that this is the law of the M. C. B. Association, both in regard to loading and interchange?

MR. KLEINE: Yes, sir.

MR. DYER: I cannot reconcile the heading of rules governing the interchange of freight cars, which says nothing whatever regarding the loading of freight cars with a statement that this book of rules governs the loading of freight cars. It does not, without the loading rules are embodied with the M. C. B. rules governing the interchange of freight cars.

MR. KLEINE: This book of rules also refers to certain M. C. B. standards. But the M. C. B. standards cannot all be placed in this small book of rules governing interchange, and in order to find out what the M. C. B. standards are it is necessary to refer to the book of standards. The same would apply to the loading rules, or to the tank car rules. But we do not want this book too large, which would be necessary if you had everything in it, and if we have our references in this book I should think that would be sufficient.

Rule No. 7:

PRESIDENT: There is one clause in that rule that always seemed to me rather indefinite; it leaves it to the judgment of each inspector. It would possibly be better to specify the number of flat spots under 2½" long which you would accept.

MR. KLEINE: It would be rather difficult to specify more closely than the rules do at the present time. It is one of the questions that must be left to the judgment of the inspector. If the wheel has shelled-out spots and they are all along the wheel and the inspector considers that wheel dangerous or liable to break, I do not believe we ought to question his judgment, and the wheel really ought to come out from a safety standpoint.

PRESIDENT: Don't you find wheels taken out that have just three or four spots not 2½" in diameter?

MR. KLEINE: Whenever we do we go over and correct the inspector who took the wheel out. Your shop man will check that up.

PRESIDENT: That may be, in some cases, but our experience is that you will get the wheel in from an outside point where it may have been laying on a siding waiting for a car load and it is pretty hard to tell who did make that inspection.

MR. JULIUS KRAUSE: You are right. But that is being corrected by all railroads. But when you speak of flat spots which are caused by sliding and only 2″ long and a number of them on the wheel and not too close together are not unsafe. But shelled out, if only 1¼″ in diameter, and a number of them located close together, the wheel should be removed.

PRESIDENT: The only objection I have is that it leaves the whole thing to the judgment of each inspector.

MR. KRAUSE: That is all you can do in that case. The inspector will be the judge and take the side of safety.

Rule No. 9:

MR. DYER: There are wheels that are worn through the chill that do not show what you would call a flat spot, and I do not think it well to depend on a dimension of that kind. If worn through the chill and there is a hollow spot on the tread, it may not be flat, but at the same time the wheel would be condemned for reasons of safety and yet there would not be a flat spot 2½″ long.

PRESIDENT: Worn practically around the entire circumference. Was that considered?

MR. KLEINE: The gentleman is entirely correct. He means to imply that you have not a 2½″ dead flat spot. Sometimes they are 4, 5, 6 or 8″ where it is getting through the chill. That point was not raised in connection with our recommendation outside of simply mentioning the length of the flat spot. But we have a recommendation under Rule 12 to get some of these bad wheels out of service, a dimension for worn treads.

Rule No. 12:

MR. KLEINE: We did not submit a print, but have the gauge here. You are possibly familiar with it, the tire gauge. It will be necessary to have two contours, one for 1⅛″ flange and one for 1″ flange. The gauge is to be applied in this way, resting the one point on the point of the flange and the other on the sand rim, the two points of the wheel that do not wear. If any point of the tread is worn ¼" below the gauge the wheel will be condemned. ⅜" is the depth of the chill and ¼" is as close as we should go. It is simply a recommendation to the M. C. B. A. to refer to the Wheel Committee to have it worked out.

PRESIDENT: In your experience would the adoption of a gauge of that kind condemn very many wheels that are now being allowed to run?

MR. KLEINE: I think the point that brought up the suggestion for a gauge of that kind is the number of wheels we are getting today that are pounding themselves to pieces. Of course, some of those wheels, we must admit, have not the minimum depth of chill, ⅜". The result is that after you are through your white iron the wheel wears very rapidly and pounds out. While the limit of ¼" may not be right and you may want to go to 5-16", your experience will have to determine that, for which reason we suggested to refer it to the Wheel Committee rather than to make a definite recommendation at this time, but simply give the Wheel Committee something to work on.

MR. J. C. WARNE: Anything that will help the wheel maker we are bound to back up.

MR. GEO. GIES: It seems to me if that limit is conformed to it will cut out quite a number of wheels that are running today, and out of which we should get considerable more mileage. There is no doubt that there are quite a number of wheels that have more than ⅜" chill.

MR. KLEINE: I would like to ask Brother Gies what he would recommend as the maximum?

MR. GIES: That would have to be looked into. I would not want to suggest any dimension. I have no doubt that if a number of wheels were examined we could come to some conclusion as to a dimension that would perhaps be more accurate, but it seems to me that ¼" is rather light.

PRESIDENT: The Committee only recommend this to the M. C. B. Association for them to study the matter and decide what depth of gauge to adopt. ¼" is merely given as a suggestion.

MR. WARNE: What is the present practice? Is there any arbitration rule or is it simply left to the inspector's judgment? Another question I would like to ask, do your rims wear down to 5-16" or ⅜" in actual service today?

MR. KLEINE: This is not a question of guess work with the Committee, as Mr. Gies suggests.

MR. GIES: I did not mean guess work on his part, I meant guess work on my part. I would not want to guess at it.

MR. KLEINE: Mr. Carson, of the New York Central Lines, has used this gauge for a number of years and finds that ¼" is about the proper limit. But the remaining members of the Committee did not have sufficient information to make that recommendation absolute, and we simply tender it as a suggestion so that the Wheel Committee can bring it before the railroads of the country and get their ideas as to what is the proper dimension, and then formulate a suitable gauge upon a suitable dimension.

Answering Mr. Warne's question, with cast iron wheels that remain in service we do not find very many where the flange is 1½" high with the old 1⅛" height of new tread, that means that the tread has worn down ⅜", which is an extreme case. But for years, among car inspectors generally, they consider ¼" wear of tread sufficient to condemn the wheel. And the way they usually handle it is to take their lead pencil and rule and lay it across the top of the flange in this manner (illustrating) and when they find the wear about ¼" they have been throwing out the wheels.

PRESIDENT: Is it not possible that a gauge of that kind would be uncertain on account of the brake shoe wearing the outer edge of the wheel at times, a brake shoe out of line?

MR. KLEINE: Here is a wheel pretty badly worn and it is condemnable for thickness of flange, but even this wheel is not condemnable by this gauge, and you will see by examining the wheel that the sand flange very rarely bears on the ball of the rail and the brake shoe wear on that part of the wheel is very slight. This would be about as good a test as any one, and if it did wear down it would be in favor of the wheel instead of the gauge.

MR. WARNE: There is a point there. A flange does not wear on the top of the flange. The brake shoe service comes on the tread and consequently that gauge is a very good one because it rests upon a point of the wheel that never has any wear. In car wheels the point of the flange is not touched. The brake shoe always runs below that. Street car service is different from railroad service, where they brake on both the flange and the tread.

MR. KLEINE: There is another question which arose since we made our suggestion, and that is that the same gauge could be used for wear on steel and steel tired wheels, with the exception that a greater limit can be allowed on account of the stronger flange of steel wheels, and some steel wheels having 1⅛" flanges originally are worn down to 1½" and even lower than that. You may want a limit of ¼" on cast iron and ⅜" on steel wheels. With that in mind it would be very practicable to adopt a small steel gauge with two measures on it, ¼" for cast iron and ⅜" for steel, which could be slipped underneath the tread and would take in both limits of wear.

PRESIDENT: Another point is that your steel wheel would be due for removal anyhow if it was worn ¼", that is, if it were ¼" higher on the outer edge than on the tread. You remove driver wheels if they are worn that much, on account of the bad effect on the switches and frogs.

MR. E. S. CHAPIN: Should not the drawing of the proposed gauge show the dimensions for the location of the center used to strike the 1⅞" radius?

MR. WARNE: My experience is that a 1⅞" radius becomes almost a tangent. I do not think that center is indicated; it is merely a curve that is adopted equal to the ⅝" radius or 11-16". It will find its center naturally because it has to intersect both these curves.

MR. CHAPIN: Wouldn't it be practicable to designate it for laying out these gauges?

MR. KLEINE: I agree with the last speaker. It is not located now on the standard contour of the wheel and comes tangent to ⅝" and 11-16", and therefore you can locate the center from the other two radii at the point of tangency.

MR. WARNE: I have recently made a lot of chillers laying out this contour of 1909 and it really amounts to nothing. The two curves 1″ high on the radius almost blend together. It is a very small portion. It is not an important matter, but only a point to correct.

Rules Nos. 18 *and* 20:

MR. DYER: This suggestion reads "Nearly all flanges that are chipped extend past center of flange, which makes it difficult, if not impossible in some instnces, to determine under the present rules whether the defect is an owner's or delivering company's defect." Taking into consideration the snow we have had this Winter, and I would say it is more difficult to determine whether the wheel is chipped or not than it is to say whether it is an owner's or delivering company's defect. It seems to me we are going backward. Track conditions may be about the same on all railroads and if it is possible for one company to chip a wheel flange it is possible for another company to chip the wheel flange under exactly the same conditions. In the winter time, with the snow, as I have suggested, it is very difficult to determine whether a flange is chipped or not; therefore, to a great extent, the defect is concealed, and if that is the right view to take of the case I would suggest that this suggestion don't go through.

PRESIDENT: We will have to take a vote on this after we finish reading them, when we will pay attention to all rules to which there have been objections.

MR. F. H. STARK: The Chicago Railway Club recommend making the owner responsible under all circumstances, and the question arose as to why the committee recommended making the owner responsible, and the chairman of the committee stated that they had found it difficult to determine on which side of the flange the chip existed, and they wanted to put the responsibility all on one, so they gave it all to the owner. In other words, they agreed that the chipped flanges were caused by track conditions and yet at the same time, as an easy way of disposing of it, they proposed to make the owner responsible. Our friend, Dyer, wants to be relieved of the responsibility when receiving cars for the roads he represents. He fully understands that it is difficult to discover chipped flanges, and if he gets the cars into his possession he would prefer to make the owner responsible. I would ask him to remember the poor private car owner who does not have any chance to reciprocate and, consequently, you can hardly make it fair to the car owner by simply assuming that the easiest way to get out of it is to make the owner pay for it.

I believe this is an equitable recommendation and any one that will give the matter any considerable study will admit that flanges are chipped more on account of track conditions than any or all other causes.

I believe the meat of this whole matter is that you do not want any chipped flanges running. They are dangerous. To make the owner responsible encourages the running of chipped flanges, while to make the delivering company responsible will cause the wheel to be removed.

MR. DYER: I am perfectly satisfied that to place all the expense on the private car owner is not just or equitable. But in view of the fact that it is hard to discover chipped flanges under certain conditions, I believe we better pay the private car owner in some other way, by allowing him something more for the use of his car.

PRESIDENT: Take up a collection for him.

MR. KLEINE: I suggest that we take a vote on this particular rule.

MR. DYER: I think we should consider that the makers of the rules and those who have permitted these particular rules to be in effect for so many years knew something about what they were doing when they made the rule as it is made, and I do not believe it would be proper to change it.

A VOICE: I would not be in favor of that change, either, for this reason: that it is very hard to determine sometimes. A brake shoe might cause it, or it might get in the rail.

MR. SAMUEL LYNN: I agree with the Committee. It should be caught by some inspector and taken out.

MR. STARK: You might apply that criticism to slid spot wheels. It is very hard to discover them under bad conditions.

MR. DYER: New 1¼″ can still be used, manufactured prior to September 1, 1909, if properly labeled.

MR. KLEINE: Mr. Dyer is mistaken on that point. According to present rules you cannot apply 1¼″ air hose in repairs; you cannot apply anything but M. C. B. standard 1⅜″ hose. While 1¼″ applied prior to September 1, 1909, is acceptable in interchange, no road can now apply it to the cars and make a bill against the owner.

MR. STARK: I agree with Mr. Dyer, but, of course, there is no use in crying over spilled milk. The Arbitration Committee have made their decision. There is no question that there has been a great deal of money put into hose that is now of no value. We can understand why it is desirable to have hose labeled M. C. B., for that indicates that it has been manufactured under M. C. B. specifications. But when we state that air hose cannot be used if the dimension 1⅜ has been inadvertently omitted, it would seem like a pretty radical enforcement of a law that doesn't bring about any results. Neither does the initial of the purchaser make the hose any better. In that particular case it indicates who is responsible for the purchasing of the hose. But that cannot now be avoided, because the Arbitration Committee have already made their ruling.

MR. KLEINE: We have got to uphold the Arbitration Committee in their ruling on air brake hose. While we are nipped the same as lots of other people by not having the proper label on our hose, at the same time the Arbitration Committee could not have ruled differently. If they allowed a single item to be eliminated from that badge plate the other fellow who had left off "M. C. B. Standard" could have said his hose was an M. C. B. standard just as well as his neighbor's hose. The only way the Arbitration Committee could decide the case was strictly in accordance with the standard badge plate. That calls for the information complete.

Rule No. 75:

MR. GIES: Why not include the bolts, nuts and plates? They are required in applying the blocks.

PRESIDENT: Do you contemplate including the whole outfit?

a large amount of money as they have in air hose at present. I do not think the suggestion should go through. It is up to the owners to remove the hose, but not the intermediate lines.

MR. KLEINE: The changes suggested by the committee are simply in line with Arbitration Decision No. 799. It makes absolutely no difference in the present practice. The delivering company is to be responsible for wrong air brake hose on cars offered in interchange, and our rules have simply been changed to conform thereto, because the old rules will become obsolete this year.

MR. DYER: I do not think it is in accordance with the Arbitration decision. That decision, as I understand it, does not give an intermediate line authority to remove a hose from another company's car on the authority of somebody else's defect card.

MR. KLEINE: It is correct that the rule has caused the railroad companies thousands of dollars, because in some way or other they did not have their badge plates to conform with the M. C. B. standard. For years the M. C. B. committee has warned the railroads through the interchange rules that they must apply air brake hose in accordance with M. C. B. standard. The only way an inspector can determine that a hose is M. C. B. standard is by the badge plate on the hose, therefore that badge plate must be strictly in accordance with the M. C. B. standard.

The making of owners responsible for all wrong air brake hose after September 1, 1909, in the first place, and after that delivering company responsible, was with the idea of getting M. C. B. standard air brake hose on the cars. If the delivering company is out of hose it can put on an M. C. B. defect card. It is for the purpose of changing to M. C. B. standard and I do not see why an intermediate road should not make that change. It is a matter of indifference whether the owner or the intermediate road removes the hose, the delivering company has put the defect card on the car.

MR. DYER: If the intent of this suggestion is to legislate those hose out of existence, I haven't anything further to say.

MR. KLEINE: That is what it is for.

Rule No. 71:

and yet we would hardly think of making slid spot wheels an owner's defect, simply because it is difficult to detect.

MR. DYER: I do not think it is difficult, if proper care is taken, to discover slid flat wheels.

MR. S. M. HINDMAN: As for the slid flat wheel, the same can easily be determined, as it can be detected by the sound.

Regarding chipped flanges, we are all aware that the same are caused by track conditions, and for that reason I do not think it is right to penalize the car owner; if a car with a chipped flange passes one of our interchange points and our inspectors fail to catch same, we would be responsible for not obtaining protection at that time.

On motion of Mr. Stark the recommendation of the Committee is adopted.

Rule No. 33:

Change to read: "Cars equipped with air brake hose other that 1⅜", M. C. B. standard, *and so branded* (*See Fig* 7), *except* cars equipped with 1¼-inch M. C. B. standard hose, and so branded, *manufactured* and applied prior to September 1, 1909, will be accepted in interchange. Delivering company responsible.

NOTE: If date of application is not cut off from badge date of manufacture will be accepted as date of application.

To agree with Arbitration Decision 799, Figure No. 7 should be included in the rules showing a cut of the standard 1⅜" M. C. B. Label for Air Brake Hose, now shown in the 1909 M. C. B. Proceedings, page 598, and sheet M. C. B. 18.

MR. DYER: I would like to know what is going to be done with the air hose that are removed from cars under present arrangements. It seems to me thousands of dollars have been paid out for air hose that have been removed and cannot be used any longer. If you permit intermediate roads to remove hose on the authority of a defect card, those hose will be used in their own service. These hose will be put to the same stresses and strains in other than interchange traffic, and I do not think this committee wants to legislate those air hose out of existence entirely and have the railroads and private car owners lose such

MR. KLEINE: We will be satisfied if we get the spacing block back. We will be willing to give the bolts, nuts and plates.

MR. GIES: If the blocks are to be returned the bolts, nuts and plates should be returned with them. You cannot use one without the other.

MR. KLEINE: There is no objection to including them.

PRESIDENT: You might make it read "Metal spacing blocks and attachments."

MR. HINDMAN: In view of the fact that this suggestion has been made to the Arbitration Committee several times and been rejected, I think it would be advisable to simply mention the spacing blocks.

MR. GIES: Ask for all the parts, and if we don't get all we may get part of them.

PRESIDENT: Give a rebate?

MR. KLEINE: The committee will be entirely satisfied to have it read "Metal spacing blocks and attachments." The committee will be very glad to accept that.

Rule No. 77:

MR. GIES: If there is any method by which you can compel the inspectors to fill out both sides of the card, I believe it should be adopted and enforced.

MR. KLEINE: It is now required to fill out both sides of the card for the reason that the outside of the card which is tacked to the car very often becomes illegible. Since the report went to print we received a suggestion that only one side of the repair card be filled out and the repair card doubled over and tacked to the car with two tacks, in order to avoid the writing. That is before you for discussion. Personally I feel that the repair card is on that car so that it can be read by the inspector, and we should not take the chances that it will not be tacked on again. As the card will not be legible for any great length of time, both sides of the card ought to be filled in and tacked to the car as required by the rules.

Rule No. 89:

MR. KLEINE: I might say that while this is a very lengthy rule and the Arbitration Committee might not feel that they want to adopt it in this elaborate form, yet it is perfectly equitable.

PRESIDENT: It is a pretty big proposition. We are just getting into the steel wheel problem and we have got to have some rules to govern the handling of them. Can we have any discussion on it?

Rule No. 112:

MR. KLEINE: There is no price given in the rules now and we did not have the New York Air Brake Company's prices for comparison, so we thought we would take the Westinghouse manufacturer's price and leave out the question of freight on the triple valve.

General:

MR. KLEINE: I might modify that by saying that in some cases the Arbitration Committee has referred to the present rules when considering steel car combination, such as three sills, but the details to which your Committee refer are other defects, such as bent end sills, etc., which are due to rough usage.

(Add to next to last paragraph the following:) Your Committee would welcome the appointment of some of the other members of the Club who are not on the Standing Committee for Rules of Interchange. These names were suggested simply on account of those now on the Committee handling the steel cars and are the ones with whom your chairman is acquainted. We would be glad to have some of the members of the Club act with us on this committee.

PRESIDENT: That is a question we can bring up later if we find there are other members who would be valuable.

This report is signed by the entire Committee of the Railway Club of Pittsburgh, and the entire report is now before you for adoption or rejection in whole or in part.

MR. A. LAMAR: I see the Committee has not made the same recommendation for the change in Rule 76 as they have given under Rule 3, showing the location of the journal boxes as A R 1, A R 2, etc., and I think that should also be incorporated under Rule 76 to be consistent.

MR. KLEINE: That is entirely correct. That should be done.

PRESIDENT: That can be added to the paper.

ON MOTION of Mr. F. R. McFeatters the report of the Committee is adopted and a vote of thanks is extended to the Committee for their able work.

MR. DYER: I would like a little information. I have understood that the Arbitration Committee in handing down their decision in 799 changes the note to Rule 33 from "Cars equipped with 1¼" M. C. B. standard air hose and so branded, applied prior to September 1, 1909," to read "manufactured prior to September 1, 1909." If I have been misled I would like to be put right.

PRESIDENT: Your understanding is that the Arbitration Committee ruled that way?

MR. DYER: Ruled that it is proper to say manufactured.

PRESIDENT: And that would give you the right to apply that sort of hose at any time?

MR. DYER: Yes, sir.

MR. KLEINE: I thought that point might not be clear to some of the members. I might read from the decision of the Arbitration Committee in Arbitration case No. 799.

"Air hose with pasters applied will not be accepted in interchange. It is to be understood, however, (as provided for in note following Rule 33), that 1¼-inch M. C. B. standard air hose, and so branded and applied, will be accepted in interchange, provided date of manufacture reads previous to September 1, 1909. If date of application is not cut off from badge, the date of manufacture will be accepted as date of application."

PRESIDENT: You can put them on and not cut out the date, if you want to save your old hose.

ON MOTION, Adjourned.

In Memoriam.

WILLIAM W. COLBURN

Our Heavenly Father, in His mysterious but all-wise Providence, has suddenly removed from among us our late friend and associate, William W. Colburn. Therefore be it

RESOLVED, That the Railway Club of Pittsburgh deeply deplores its loss and extends to his bereaved family and friends our sincere and heartfelt sympathy in their hour of sorrow; and be it

RESOLVED, That these resolutions be spread on the minutes of this Club and a copy of same presented to his family.

JOHN D. CONWAY,
HOWARD E. SWARTZ,
ROY L. SLOCUM,
Committee.

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EDWARD KERR, President

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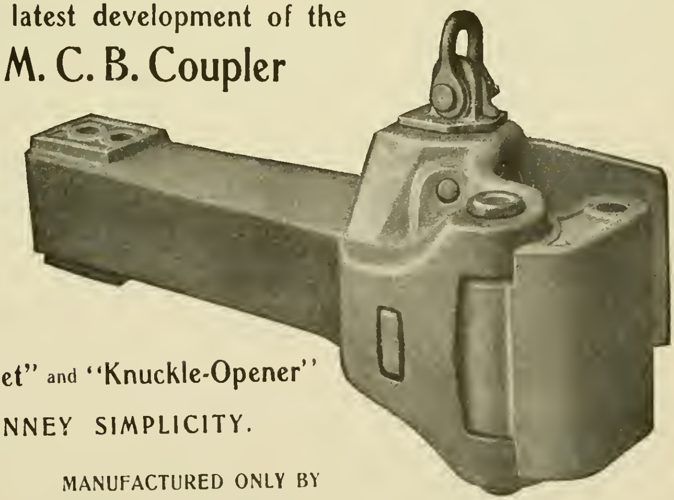

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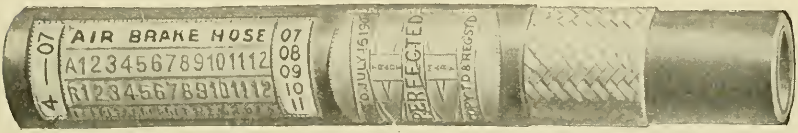

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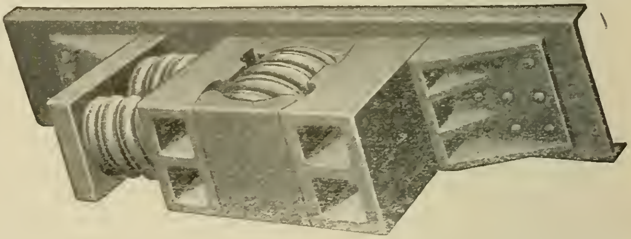

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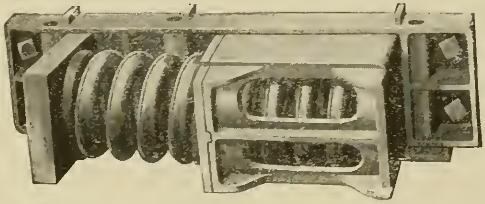

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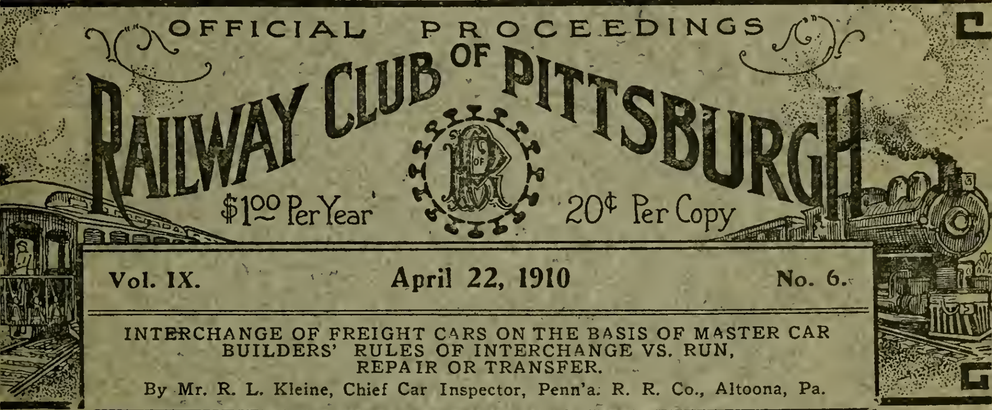

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RAILWAY CLUB OF PITTSBURGH
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Vol. IX. April 22, 1910 No. 6.

INTERCHANGE OF FREIGHT CARS ON THE BASIS OF MASTER CAR BUILDERS' RULES OF INTERCHANGE VS. RUN, REPAIR OR TRANSFER.

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Testimony From the Actual Users (8*)

℄ From time to time we have published statements regarding the merits of the "MODERN BOILER TUBE," i. e., the steel tube.

℄ In the last analysis, the success of any article must depend upon its own specific merits as evidenced by the experience of actual users.

> "I started in on the steel tube, I think, in 1896. We made a three year test of them. Regarding pitting, my experience does not go so far, but as far as our water is concerned, it is very hard lime water. The pitting only takes places in places that have real pure water. As far as service is concerned, just as Mr. (......) had in his report, the end that is in the sheet, when the flues are removed, is heavier at the present time than the iron flue would have been in three months' service, and the flues at the present time are not removed on account of the flues being worn out, but simply to get the mud and scale out of the boiler."

℄ At the 1909 Convention of the International Master Boiler Makers' Association, held in Louisville, Ky., there was a discussion of the report of the Committee on Boiler Flues, and we quote from the published proceedings the remarks of the representative of a large railroad:

℄ We call attention in the above to one point, viz: this gentleman started the use of steel tubes a number of years ago (at a time when very few steel tubes were used). The boiler tube today, by reason of better knowledge of requiremnts to which it must be subjected, has been improved.

℄ We formerly made both the steel and iron boiler tube.

℄ Becoming convinced, however, by our experience and the experience of many others, that the steel tube was the MODERN BOILER TUBE, we discontinued the manufacture of iron tubes, and are now devoting our entire attention in the boiler tube line to the steel tube.

℄ We make two kinds of steel tubes:

(a) The SHELBY SEAMLESS STEEL boiler tube. These tubes are just what their name implies, i. e., seamless, being made from a pierced billet without seam or weld. This type of steel boiler tube has been adopted by the United States Navy, after the most rigid tests possible.

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*We have issued seven announcements regarding the "Testimony from the Actual Users" in previous issues, and the above is the eighth of the series.

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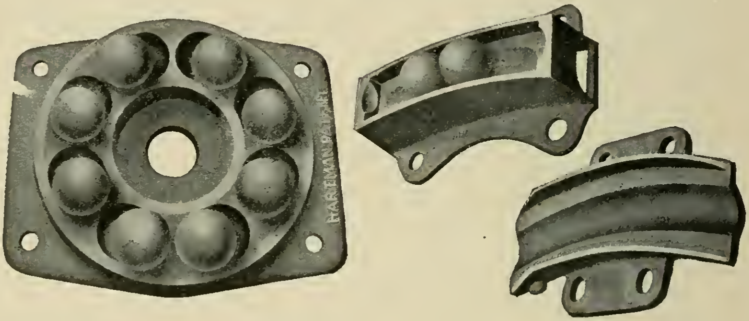

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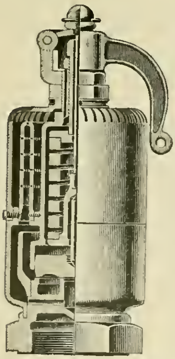

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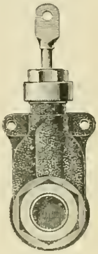

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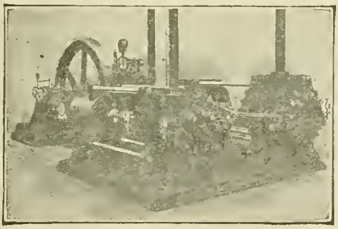

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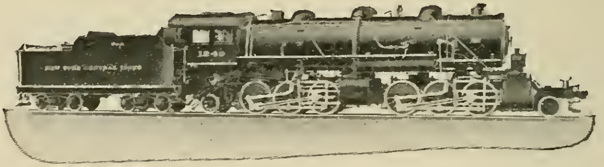

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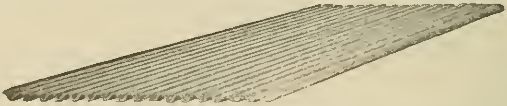

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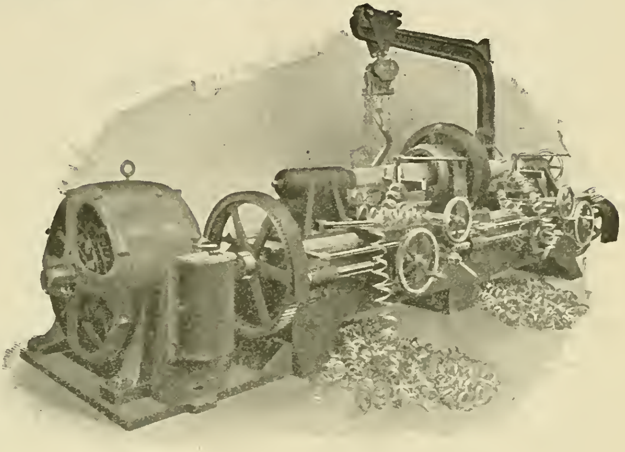

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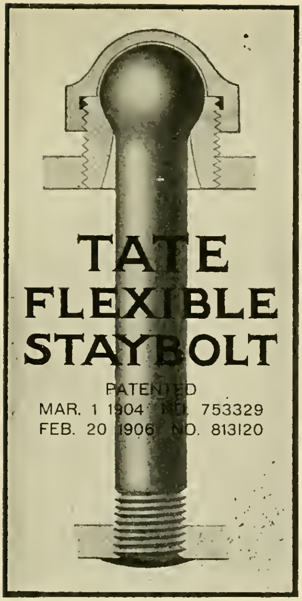

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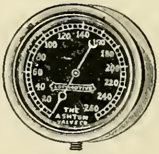

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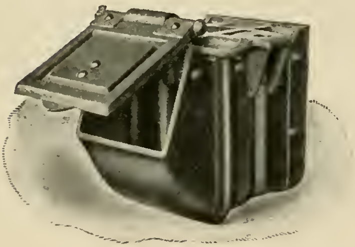

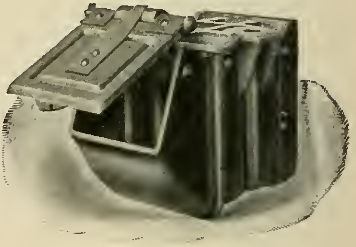

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Railway Club *of* Pittsburgh.
ORGANIZED OCTOBER 18, 1901.

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING,
APRIL 22nd, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

The following gentlemen registered:

MEMBERS.

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Curtis, H. C.
Delaplane, J. L.
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Downs, Joseph J.
Drake, W. C.
Dyer, Joseph,
Elliott, M. W.
Fettinger, H. O.
Gallinger, Geo. A.
Gale, C. H.
Gies, Geo. E.
Grewe, H. F.
Gutierrez, S. J.
Haas, Benj.
Hall, C. W.
Hepburn, M. J.
Hilberry, H. H.
Hinsdale, Clare L.
Hood, D. G.
Howe, D. M.
Huyett, E. G.
Jenney, Jacob
Kennedy, Jas.
Kinter, D. H.
Kleine, R. L.
Kleinhans, H.
Knight, E. A.
Koch, Felix
Krause, Julius
Kull, W. A.
Lehr, H. W.
Leonard, Jas., Jr.
Lewis, A. J.
Lewis, Jas. M.,
Lindstrom, Chas. A.
Lobez, Pierre L.
Long, R. M.
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McKeen, J. W.
McNulty, F. M.
Nessle, J. B.
Nickerson, S. N.
Noble, H. S.
Pfeil, John
Platt, J. G.
Porter, H. V.
Post, Geo. A.
Postlethwaite, C. E.
Quest, W. O.
Radcliffe, C. R.
Ralston, J. S.
Rauch, T. T.
Rea, C. S.
Redding, D. J.
Rinehart, H. W.
Robinson, J. R.
Rupp, R. D.
Russom, T. H.
Ryan, W. F.
Sanville, W. F.
Searles, E. J.
Shipe, Warren E.

Slemmer, W. M.
Smith, A. D.
Smith, D. W.
Smith, Russell
Stafford, Samuel G.
Stark, F. H.
Stiles, L. A.
Stucki, A.
Suckfield, G. A.
Sweeley, G. P.
Symington, C. J.
Tate, R. H.
Taylor, H. G.
Tesseyman, J. E.
Thomas, J. H.
Turner, L. H.
Walker, J. W.
Walther, G. C.
White, J. D.
Williams, W. W.
Wood, Ralph C.
Woodings, Emanuel

VISITORS.

Albers, L. H.
Allen, C. W.
Alton, E. E.
Boutet, H.
Brown, F. M.
Burton, T. L.
Conway, Scott M.
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Scott, W. A., Jr.
Sladden, F. T.
Slaybaugh, H. B.
Smith, Sion B.
Smoot, W. D.
Taylor, Frank C.
Toomey, J. J.
Tyrie, D. G.
Walker, E. H.
Walter, P. S.
Wagoner, Henry

The reading of the minutes of the last meeting was dispensed with, they being in the hands of the printer.

The Secretary read the following list of applications for membership:

Bengnot, J. J., Assistant General Foreman, Pennsylvania Co., Conway, Pa. Proposed by E. A. Knight.

Black, Frank J., Assistant Master Mechanic, Carnegie Steel Co., Island Ave., McKees Rocks, Pa. Proposed by D. J. Redding.

Brown, L. M., Salesman, McKenna Bros., 253 Virginia Ave., Pittsburgh, Pa. Proposed by D. J. Redding.

Forsythe, Geo. B., Foreman Freight Car Builders', Pennsylvania Co., P. O. Box 95, Conway, Pa. Proposed by E. A. Knight.

Hauser, W. M., Chief Clerk, Accounting Department, Wabash-Pittsburgh Terminal Ry., Wabash Building, Pittsburgh, Pa. Proposed by C. O. Dambach.

Klein, L. S., Treasurer, American Car Screen Co., Ferguson Building, Pittsburgh, Pa. Proposed by J. D. Conway.

Morgan, Dwight C., Vice President and General Manager, Pittsburgh & Shawmut R. R., Kittanning, Pa. Proposed by C. S. Rea.

McClintock, John D., Rep., Wm. Sellers & Co., Inc., 1600 Hamilton St., Philadelphia, Pa. Proposed by F. M. McNulty.

Parry, Wm. I., Engineer and Salesman, Carnegie Steel Co., Carnegie Building, Pittsburgh, Pa. Proposed by R. B. Woodworth.

Raedel, Wm. P., Engine House Foreman, Pennsylvania Lines West, No. 421 Harmony St., Rochester, Pa. Proposed by E. A. Knight.

Scott, W. A., Jr., President, American Car Screen Co., Ferguson Building, Pittsburgh, Pa. Proposed by J. D. Conway.

Smith, A. M., General Manager, Coal & Coke Railway, Elkins, W. Va. Proposed by A. Stucki.

Wescoe, F. B., Stockkeeper, Pennsylvania Co., P. O. Box 337, Conway, Pa. Proposed by E. A. Knight.

PRESIDENT: When these names have been favorably passed upon by the Executive Committee, the gentlemen will become members.

The Secretary announced the death of Mr. Frederick Mortimer Robinson, of the Pressed Steel Car Co., whereupon the President appointed Messrs. C. E. Postlethwaite, D. C. Noble and Henry Gulick a committee to draft suitable memorial resolutions.

PRESIDENT: If there is no further business, the paper of the evening, by Mr. R. L. Kleine, Chief Car Inspector of the P. R. R., will be presented.

INTERCHANGE OF FREIGHT CARS ON THE BASIS OF MASTER CAR BUILDERS' RULES OF INTERCHANGE VS. RUN, REPAIR OR TRANSFER.

BY MR. R. L. KLEINE, CHIEF CAR INSPECTOR, PENNSYLVANIA R. R. CO., ALTOONA.

Mr. President and Gentlemen:—The title of this paper has been a subject for discussion at a number of Railroad Clubs within the past year, and mechanical periodicals have commented on many phases of this question, although, up to the present time, no definite conclusions have been reached. As the question at issue is a vital one and inasmuch as the railroads centering in Pittsburgh are interchanging cars strictly in accordance with Master Car Builders' Rules of Interchange, it might be well to study carefully both sides of this question with a view of ascertaining what is involved.

In the first place, I would like to state that I am an advocate of interchanging cars with the least number of rejections or so-called "set backs," or in other words, "twentieth century inspection," but I cannot agree that this will be accomplished by the so-termed "run, repair or transfer" proposition, and I will endeavor to point out that the latter will eventually retard instead of facilitate the movement of the loaded car to destination.

The principle to be effected is the handling of the business of the country, that is, the load from the point at which placed on the car to destination with minimum delay. Under ideal conditions this result would be obtained with a car of proper construction and in such state of repairs as to render it safe to load and safe to handle, the load properly loaded and secured on the car not only for safety, as far as the load and car are related, but also the clearance and load limits of the road or roads over which the car under load must move. If this be true, the system which will place a premium on the condition of the car and load at the initial point will be the one to insure least delay to the load and car in transit. Let us consider whether this condition will be met by the adoption of the run, repair or transfer system or by strict adherence to and proper application of M. C. B. Rules of Interchange.

NECESSITY OF INSPECTION.

Cars are inspected for two general reasons, first and fundamentally to insure their safety; and secondly to determine the responsibility for the physical condition of the car.

First—*Safety*. The inspection for safety covers:

a. General construction. To determine whether the details of the car are of sufficient strength to be hauled with safety in the trains over the road to which it is being delivered.

b. Physical condition. To insure the underframes, draft rigging, wheels and other parts of trucks, doors, roofs and safety appliances being in proper repairs in order that the car may be safely handled to destination.

c. Loading. This applies mostly to loads on open cars, where close inspection is necessary to see that the lading is within the clearance limits of the road over which the load is to pass, as well as to know that the load is properly braced and blocked.

d. Clearance and load limits. That no cars are forwarded that exceed the clearance and load limits of bridges and tunnels.

e. Tank car requirements. That cars conform to these requirements to prevent serious consequences from accidents.

f. Rules and regulations for the transportation of explosives. All cars loaded with explosives, inflammable articles and acids must conform to the American Railway Association rules and the Interstate Commerce Commission regulations governing the transportation of these articles.

Second. The determination of responsibility for condition of car resulting from service while not of the same relative importance as the safety of the car is essential from the financial standpoint of the parties interested.

M. C. B. RULES OF INTERCHANGE.

The Master Car Builders' Rules of Interchange, aside from other points covered in these rules, definitely set forth the responsibility of the car owner as well as the responsibility of the handling, or, commonly termed, delivering company. An analysis of that part of the rules pertinent to this paper shows that the following underlying principles are maintained in determining the responsibility for repairs, viz:

First: Car owner's responsibility is so placed that it tends to improve the general construction of the car, especially in the essential features, such as draft sills, coupler, draft rigging, wheels and other truck parts, doors, etc., and places a premium upon the car owner in maintaining these parts in serviceable condition by providing that the owner of the car is chargeable with the expense, labor and material for specified parts broken, worn out or missing in fair service.

Second. Damage to cars caused by rough handling, also damage resulting from accident or derailment is chargeable to the road handling the car, or what is termed the delivering road, thus protecting the car owner in case the car is misused. The parts which constitute combinations of damages for which the handling road is responsible, are further definitely defined and are so based as to eliminate from combinations certain details which in themselves if too weak to stand the service makes it unprofitable to the owner to allow such weakly constructed cars to remain in service.

Third. In order to insure the handling road making prompt and proper repairs to certain parts of the equipment essential to safety and with the view of retaining the car in service without additional damage, it penalizes the delivering road by making them chargeable with the repairs for their failure to make the repairs and bill the owner of the car; in other words, certain defects for which the car owner is responsible when developing on the handling road if not repaired become delivering company's responsibility when offered in interchange.

INTERCHANGE OF CARS BASED ON M. C. B. RULES.

Railroads who become subscribers to the M. C. B. Rules of Interchange do so on the following conditions:

Conditions of Acceptance of This Code.

"Rule 128. Any car owner or railway may become a partiy to this code of rules by giving notice through one of its general officers to the secretary of the Master Car Builders' Association.

"Railroad companies becoming subscribers to this code of rules must have a representative member in the Master Car Builders' Association.

"Rule 129. Any car owner or railway company that is a party to this code of rules shall be bound by same through its successive revision, until one of its general officers files with the secretary of the Master Car Builders' Association its notification of withdrawal.

"Rule 128. Any car owner or railway may become a party must be as a whole, and *no exception to an individual rule or rules shall be valid.*

Unless interchange agreements are based on the M. C. B. Rules of Interchange they violate the contract made by the general officers of the railroads interested, and all such local agreements which supplant any of the interchange rules directly affect all the cars and railroads who are subscribers to the rules. Unfortunately, most of the so-called interchange agreements deviate from the rules in that they pass cars on notation instead of placing the defect card on the car at time of delivery, or abrogate those rules which provide for defect carding for material missing from cars offered in interchange, or entirely disregard a rule to avoid responsibility. On account of these various deviations many questions have arisen locally which required adjustment, and it is matters of this kind that have added considerable annoyance to officers in charge of large terminals already overcrowded with work.

Notation Record: Take for example cars being passed on notation record. There are probably 10 to 15 miles between the yards of the delivering and receiving company and inspection is made usually in the receiving company's yard, and if defects are found for which the delivering company is responsible, a notation is made of the defects and car allowed to proceed. This record is forwarded through a routine channel until it reaches the delivering line, who then traces to ascertain the condition of the car when received on its line, and so on until the record is lost, when the defect card is furnished. When the card is received, which may be anywhere from a few days until months have elapsed, the car has either been repaired or moved to destination. There is an erroneous impression abroad that it would require too much time and delay to freight to make out the defect card, but I contend that less time and money would be spent by making out the defect card the first time the defect is discovered and tacking it on the car, and that the movement of the car will in no way be interfered with, providing, of course, the car is safe to move, and if unsafe the sooner the car is repaired the better. The notation record must be taken and recorded every time the car is interchanged.

Failure to Defect Card for Missing Material: This is another rule largely abrogated on account of avoiding the responsibility for issuing defect card. The lost material is on the delivering line and the rules have very wisely provided that for the failure of the delivering line to make repairs it is penalized by having to issue a defect card when offering the car in interchange, for the reason, as above explained, of keeping the car in repairs. Abrogating this part of the rule directly affects the condition of the car in that it is not repaired and fails to give the provided protection to car owner.

Failure to Enforce Individual Rules: For example, the M. C. B. Association passed Rule 33 providing that all air hose on cars interchanged after a certain date must be in accordance with Master Car Builders' standards, and in order to enforce this rule, as it was a safety measure, made the delivering company responsible, after a certain date, for cars offered in interchange not equipped with standard hose. Some of the local interchange agreements decided to abrogate this rule, as they did not feel warranted in enforcing it on account of the expense involved, notwithstanding that it was a safety requirement.

The above cases are cited for the reason that claims are made by some parties that the rules are responsible for delay to freight movement, but the contrary is the case, for if the rules were enforced there would be less delay ultimately.

Interchange Based on the Rules: There are other interchange points that have entered into local agreements, either written or verbal, which interchange cars strictly in accordance with the M. C. B. Rules of Interchange, these local agreements covering where the repairs shall be made to all cars requiring shopping, and, furthermore, with a view of eliminating from forwarding to the interchange point cars in defective condition. Such interchange points experience little or no trouble from setbacks, as this practice is not resorted to, it being understood beforehand that loaded cars will not be turned back, but that the delivering company regulate the condition of the cars interchanged. At such points when it is necessary to send to shop any number of loaded cars, either for repairs or transfer, the matter is taken up with the delivering line which follows it to the point of loading and has the condition of future cars to be interchanged corrected before loading, or where the proper placing of the load on the car is involved the question is taken up with the loading point. Such interchange points are either run by joint inspection or one road has the defect cards of the other road in their possession and issues them as may be necessary, the stubs or carbon duplicates being returned to the delivering company for checking. As the decisions are all based on the M. C. B. Rules of Interchange no questions arise which cannot be mutally adjusted, although the car under load has either gone forward or been transferred. In the latter case the delivering line pays the cost of transfer, which is also in accordance with American Railway Association Rule No. 15.

RUN, REPAIR OR TRANSFER.

While the advocates of run, repair or transfer differ among themselves as to details, their general contention is that the receiving road should receive loaded cars in any condition in which they may be delivered and after receiving the loaded car have the option of running the car in the condition received, repairing the car if necessary or transfer the load, the fundamental object, is I understand it, being *the prompt delivery of freight at its destination and the avoidance of the setting back of cars at interchange points.* The object is correct, but it cannot be attained by throwing the burden on the receiving road. We should strike at the root of the trouble and repair the defective car when empty and before it is loaded to the interchange point. The placing of the responsibility on the receiving road of repairing the car or transferring the load does not facilitate the movement of the load, for, in order that the car may be moved safely it must either be repaired or the load transferred. The proper course to pursue is to strike at the heart of the cause of detention and correct the defective equipment before loading, which will not only relieve the interchange point of the necessity to make repairs or transfer, but will expedite the delivery of the commodity loaded in the car. Run, repair or transfer is mandatory and compels the receiving line to receive the loaded car in any condition that the delivering company may see fit to deliver the car and thus provides an outlet for bad order cars under load, and instead of stimulating the movement of the load will retard it and be the direct cause for a lower standard of maintenance of equipment with resultant break-downs and accidents; in other words, place a premium on bad order cars, thereby defeating the object of M. C. B. Rules of Interchange, which provide for proper car maintenance.

The M. C. B. Rules of Interchange are held responsible in some quarters for the delay to loaded freight cars, particular reference being made to Rule No. 2, reading as follows:

> "Cars offered in interchange must be accepted, if in safe and serviceable condition, the receiving road to be the judge in cases not provided for in Rules 3 to 56, inclusive.
>
> "In case cars are rejected by the receiving road and returned to the delivering company, all the defects objected to must be designated on a return card 3½x8" of the following form, filled in with ink or black indelible pencil, and placed on the car adjacent to the destination card."

I do not believe that the management of railroads will empower the Master Car Builders' Association, or, for that matter, any other association, with the right to dictate that they must receive loaded cars under any conditions, thus blocking up their receiving terminals with bad order cars, cars improperly loaded or cars not equipped to meet safety requirements of the road over which they are to be transported. The roads working under the Master Car Builders' rules are alive to the fact that it is unwise and unprofitable to reject any cars for movement, especially loaded cars, but they do insist that they have a voice in the matter of the kind and condition of cars that are safe to be hauled in their trains and over their line. Where such roads have agreements to accept cars without backward movements they have gone into the question and after considering whether it is more convenient from the standpoint of yard and shop facilities for the receiving road to do the work or whether the delivering road should make the repairs, have definitely fixed the place where such cars are to be repaired. In some cases a number of roads have entered into a joint agreement and established a joint inspection and repair yard under the jurisdiction of an independent management for the prompt inspection, repairs and economical movement of freight, based on the M. C. B. Rules of Interchange, and the rights of each member as to safety requirements and other instructions are followed; but there is nothing in these agreements that violate a single rule of the Master Car Builders' Rules of Interchange.

Receiving Road Responsible for Cost of Transfer: Some are in favor of receiving road being held responsible for the cost of transfer of lading. It is a well-known fact that some roads have inadequate shop facilities to take care of their bad order cars, and it becomes necessary to have the cars repaired by outside parties; whereas, other roads have provided sufficient shop and repair track facilities to do their work, although at times when the movement is heavy these facilities are taxed beyond their capacity. At such times individual repair shops are also crowded, generally with new work, and, therefore, unable to care for the bad order cars. Under the run, repair or transfer order of things the receiving road must accept the loaded car and if unfit for movement, either repair the car or transfer the load; in the latter case the empty car is returned to the delivering line and there is nothing to prevent the delivering line to again load the defective car and forward to the interchange point, and the receiving road can again transfer the load at its expense, return the car, and the same procedure repeated indefinitely, or until the car breaks down. While it may be claimed that this can be done at certain interchange points at the present time, I wish to state that I believe this is directly responsible for a number of the equipment failures that are experienced today, inasmuch as the receiving line does not have adequate facilities to make repairs or transfer the loads. Under the M. C. B. Rules of Interchange and agreements based thereon this matter can be controlled, and in does not involve any set-backs. For example: A certain line of cars reach interchange point with defects which are causing trouble, the receiving road still has the right to refuse cars or transfer the same at the expense of the delivering line, but before exercising the right to refuse cars it brings the matter to the attention of the delivering road, who in turn takes the necessary steps to have the cars repaired. If the amount of transfer bills run up during any month the matter is investigated, the responsibility ascertained and the root of the trouble corrected, instead of throwing the burden on the receiving road and continuing the delay to the loaded cars.

I might cite another case coming under the jurisdiction of an interchange point, working strictly according to Master Car Builders' rules, governed by an independent management, no loaded cars being returned, but repaired or transferred, as may be necessary. At this point a number of loaded cars were received not loaded in accordance with M. C. B. rules for loading, thus requiring readjustment of lading. While the delivering road was paying for the readjustment, there was delay to freight and increased shifting and shop work, as well as expense involved, and in order to avoid the same on future shipments, the matter was taken up with the road receiving the lading from the shippers and the necessary corrective measures applied. The same amount of interest and prompt action would not be displayed under the run, repair or transfer slogan, especially should the burden of expense be on the receiving road.

TANK CAR REQUIREMENTS, LOADING RULES, ETC.

Aside from the rules of interchange all roads do not enforce the Master Car Builders' standards for loading materials and the recommended practice for tank car requirements. Dealing strictly with this phase of the question from a purely interchange standpoint, although I can see no valid reason why any road should have two standards for safety requirements of this kind, all roads should enforce these rules on all cars interchanged so as to insure a tank car or load on open car going to destination without being held up in interchange for non-compliance with either the M. C. B. tank car requirements or loading rules. If the car becomes defective or the load disarranged in transit the necessary repairs must, of course, be made at an interchange point the same as would be the case at any en route inspection or repair point.

DESIGN OF CARS.

Cars have been designed in the past mainly from the standpoint of the requirements of roads for which they were built and the shipping interests which they serve. These requirements are not similar on the different roads on account of the varying demands of territory served, topography of road traversed and the motive power employed. This has resulted in a wide range of design, and consequently there are in service today cars varying greatly in regard to capacity and strength; furthermore, the capacity of the cars has greatly increased within the past ten years and while steel and steel underframe cars are generally being built at the present time, there are in service a large number of wooden underframe cars with obsolete and weak design of underframe, draft rigging, etc., brought about by the rapid strides which have been made in the increased capacity of cars and improved design. On some railroads the necessity for improved design of cars has not been so apparent as on some of the larger roads, for which reasons the equipment is not uniform, and it is found that while the lighter equipment can be handled on the home road with perfect safety it does not meet the demands of the service on the more rigid inspection in some territories than in others. The roads employing the larger and heavier equipment, thus involving Master Car Builders' Association in their standards and recommended practice have gone a long way towards standardizing certain parts of the equipment, especially those parts involved in common repairs, and this work is being amended from year to year to keep pace with the progress of the times, and railroads are more generally following these standards and recommended practices, thus facilitating repairs on cars interchanged and reducing the time cars are in shop for such repairs. The Rules of Interchange are modified from year to year to keep abreast of the standards making it compulsory to employ these standards in certain items of repairs which hinge upon safety.

The Master Car Builders' Association have a standing committee on Standards and Recommended Practices as well as an Arbitration Committee, the latter having in charge the interchange rules. These committees request, yearly, suggestions for changes or modifications and therefore if the standards and Rules of Interchange are not satisfactory or do not cover the situation properly we alone are to blame, as ample opportunity is afforded for revision.

JOINT INSPECTION.

Joint inspection is to be welcomed as long as it is based strictly upon the Master Car Builders' Rules of Interchange and does not abrogate any single provision of these rues, as it reduces the number of inspectors necessary to carry on the work and results in more uniform interpretation of the rules. Usually these joint inspection points ahe under the leadership of a chief joint inspector, sometimes called an arbitrator, and upon him rests the duty to see that the Rules of Interchange are uniformly and impartially applied. Unfortunately the special agreements above referred to usually abrogate one or more of the Rules of Interchange which makes the chief joint inspectors duty complicated. At some points the chief joint inspector must first see the car to fix the responsibility before he issues a transfer order, thus delaying the shipment or transfer to that extent. In other cases he is compelled to issue the defect cards or is simply empowered to O. K. the request for defect card; in either case the defect card is not tacked upon the car, where the M. C. B. Rules provide it should be placed, and irregularities follow in billing upon such defect cards. There is no reason whatever why the proper defect cards and repair cards should not be in the hands of the inspector making the inspection, which will do away with irregularities and the manifold duplication of notation record, also consequent tracing, thus conforming strictly to the Rules of Interchange. The chief joint inspector can then supervise the work generally to see that the inspection and minor yard repairs are efficiently made and the work carried on with dispatch. The checking of the defect cards and transfer orders will give him a line on the origin of the defective equipment or loads and enable him to take the necessary steps in appraising the roads responsible for the conditions existing with a view of avoiding future unwarranted delays.

There is no question that the chief joint inspectors in charge of these large terminal inspection points are efficient men and if the special agreements now existing, which do not conform to the Rules of Interchange, were revised in accordance with the rules, not only the spirit of the rules would be carried out, but more satisfactory interchange would be had and less delays to the cars and their loads would be experienced.

The question has been raised that inspectors reject loads from the standpoint of "getting even." While this was the case to a very limited extent in days gone by, I personally do not know of it existing today; if it does, the officers in charge of such inspection points should apply the necessary corrective measures without delay.

CONCLUSIONS.

In summing up I append briefly the basis on which cars should be interchanged so as to maintain safety of the car and lading and which will, at the same time, result in a minimum amount of delay to the load in transit:

1. Cars to be interchanged should be of such design that can be safely hauled on the lines over which billed and all physical defects repaired before the car is loaded so as not to retard its prompt movement to destination, except for such repairs to defects arising en route.

2. That the Master Car Builders' Rules for loading be complied with so as to insure the lading to be safe, within the clearance and load limits and acceptable to the roads over which the car and lading is billed.

3. The construction of all tank cars interchanged should conform to the M. C. B. requirements for tank cars to avoid detention at interchange points.

4. That all cars loaded with explosives, inflammable articles and acids conform to the American Railway Association Rules and the Interstate Commerce regulations governing the transportation of these articles, in order to avoid delays at interchange points.

5. That all railroads and members of the Master Car Builders' Association take more active interest in the Rules of Interchange and the standards and recommended practices of the Master Car Builders' Association, so that the revisions made from year to year will embody the essential details and thus promote the safety of the cars and ladings, facilitate interchange and repairs to cars in transit.

6. Abrogate all existing interchange agreements, verbal or written, which in any details are contrary to the Master Car Builders' Rules of Interchange and reconstruct them so as to conform in every detail to the M. C. B. Rules of Interchange. Local agreements providing for the repairs to defective cars, adjustment or transfer of lading without return movement of the cars are necessary and desirable; such agreements must, of course, be mutually equitable and based upon the facilities available where such inspection, repairs and transfers can be made. The receiving road, under these conditions, retains the right to refuse any car or lading for transportation over its lines which may not be safe to haul, and also has the privilege of placing an embargo on any defective line of cars or ladings in bad condition, thus avoiding congestion and transfers at interchange points.

PRESIDENT: There are a number of gentlemen interested in this subject who are unable to be here, but have sent in written discussions. These will now be presented.

THE DELAWARE & HUDSON COMPANY.

Albany, N. Y., April 18, 1910.

Mr. C. W. Alleman, Secretary Railway Club of Pittsburgh, Pittsburgh, Pa.:

Dear Sir—Your letter of April 15. Regret at this time I cannot give myself the pleasure of attending your meeting and hear the discussion on this interesting subject.

Agree generally with the author that the so-called run, repair or transfer will not improve the conditions looking to more active movement of cars, than now afforded by the M. C. B. Rules, as periodically corrected to meet changing conditions, etc.

Reference is made to Rules 3 to 56 inclusive. There are often prevailing conditions effecting point of inspection and the manner of repairs due to facilities of one line or the other, which can, and generally are, arranged for the convenience of both the receiving and delivering line in effecting more prompt repairs. For instance, where one line is obliged to have a large repair force they are used to facilitate the repairs of cars on the line with the lean force to effect deliveries. Again, where one line has a steam wrecking car it is used for both companies in the trimming or transferring of loads for the same reason. However, as indicated in the paper, is carried on in accordance with M. C. B. Rules as to charge, manner of doing the work, responsibility, etc. Where a joint inspection can be introduced, so as to have one mind interpret the rules for all, it is a further advantage.

There are no advantages that the so-called run, repair or transfer arrangement would afford over this. Am sure no road wants to handle a car that will not permit of safe operation and in accordance with the law, nor do they want to shift the responsibility for repairs. Am, therefore, at a loss to see any advantage to be gained. We don't want to introduce any method of inspection that would be an incentive to lower the standard of maintenance.

We have a point on our line where the interchange of cars is handled in this manner, i. e., joint inspector, receiving and delivering line repairing, billing, carding, etc., under the rules, and it has resulted in a great reduction in the amount of switching and setting back of cars. The setting over for delivery cars with heavy repairs, wheels, etc., is avoided; they being subject to an inspection, set upon the delivering line's repair tracks for the necessary.

Trimming of load: This should be done by the road having the best facilities, delivering line to pay the bill. This to prevent carelessness, encourage investigation, which might otherwise be overlooked if the other fellow done the work and paid the bill.

On the page of conclusions, am strictly in accord with the author. This will prevent distortion of the rules, cause all interchange points to be in accord without preventing any advantages that can be taken of facilities enjoyed by one line and not the other where cars are interchanged.

Where dissatisfaction with the M. C. B. Rules exist it is due generally to improper application or conflicting with some local arrangement, either at the point of dissatisfaction, or a neighboring connection. An arrangement for the receiving road to repair cars delivered by a connection should not cause a car to be run in any poorer condition than if the delivering, or both roads, jointly done the necessary. It keeps the responsibility with the road assuming or creating it. Therefore, the interchange of cars on the run, repair or transfer arrangement affords no condition that is not taken care of under the present M. C. B. Rules, and has the disadvantage of creating a condition that encourages a lower standard of maintenance. With our fast time and large trains, quite the opposite is to be desired.

With the M. C. B. Rules broadly, honestly and intelligently interpreted, as expected in their application, there will be no unnecessary holding up cars at interchange points. Surrounds receiving road with a greater assurance of safety (inspection, independent of repairs), places the responsibility and expense where it belongs, and encourages proper maintenance and design.

Trusting you will have a pleasant and profitable meeting, I remain, Very truly yours,

J. H. Manning,
Supt. Motive Power.

NEW YORK CENTRAL & HUDSON RIVER R. R. CO.

West Albany, N. Y., April 15, 1910.

Mr. D. J. Redding, President, Railway Club of Pittsburgh, Pittsburgh, Pa.:

Dear Sir—I have read with a great deal of interest the advance copy of paper on "Interchange of Freight Cars" to be read at the meeting on April 22nd, and believe that Mr. Kleine has covered the subject thoroughly, and I agree with his ideas on the subject. I see the necessity of interchanging cars with as little friction and delay as possible and under the most favorable conditions the interchange is more or less troublesome, for equipment which is considered in the best of condition on its arrival at interchange points the inspectors find many repairs to make, such as keeping up safety appliances, renewing air hose, brake shoes, worn knuckles, brake levers, connections, etc. Now, if the equipment is to be interchanged regardless of its condition I cannot see wherein it is going to eliminate delays, for a disabled car must be forwarded to some repair track, and it is a question in many cases whether the delay would be prolonged by giving it a back-movement or sending it to the receiving road and they in turn send it out of route to one of their shops 15 or 20 miles away. At most interchange points up-to-date railroads are generally equipped with repair tracks, and in my opinion that is the place to cut the cars out and put them in shape to go to destination.

I am a firm believer of close inspection at interchange points and where such points are handled properly you will find that there are no cars stopped except those which are not fit to be given a back-up movement or go forward. Furthermore, I have seen about as many cars held at interchange points on account of improper billing or no billing as there were shop cars, and I question whether another road would accept a car without billing, which is a safer proposition than to accept a string of cars that are liable to wreck themselves and tie up the system.

The advisability of close inspection has been discussed from time to time, but it has never been discussed very sincerely by that part of the management which is held directly responsible for the cost of maintenance and the care of their equipment. The longer the repairs are delayed the more costly they are. So I contend that from an economical standpoint a defective car should be repaired as soon as possible and before it receives additional damage through some minor defect. I am sure we would do this if it were our individual property. As an object lesson, it would be well for the doubtful to visit any of our large freight yards and see the millions of dollars' worth of first-class equipment deteriorating physically, all for the want of care and attention. It would sometimes lead one to believe that it would be cheaper to dispense with the repairs, close up the shops and buy new equipment when needed.

If we are to interchange cars in a loose manner it will only be a short time until the cars will be so defective that we will not be able to haul them to an interchange point. So let us have good inspection, plenty of repair tracks and a liberal supply of material and help and being so equipped there will be little friction at an interchange point.

Yours very truly,

C. E. CARSON,

Division Master Car Builder.

CHICAGO, BURLINGTON & QUINCY RAILROAD COMPANY.

Plattsmouth, April 19, 1910.

Mr. C. W. Alleman,

Motive Power Dept., P. & L. E. R. R. Co., Pittsburgh, Pa.

My Dear Sir:

I am in receipt of your letter of April 15, together with advance copy of paper on "Interchange of Freight Cars on the Basis of M. C. B. Rules of Interchange vs. Run, Repair or Transfer."

I certainly appreciate your very kind invitation to be present at the meeting on Friday evening, the 22nd inst., and regret to say that it will be impossible for me to be present on that date.

I have read with much interest the paper of the evening by Mr. Kleine, but the time has been very limited in which to give it the thought that it requires. I must say, however, that after reading the paper over I am not quite clear as to where Mr. Kleine really stands in the matter of Twentieth Century Inspection. He is not positive enough in his opinions to clearly define to an outsider just where we can expect to find him in this matter.

In the first place he starts out by saying "I am an advocate of interchanging cars with the least number of rejections or so called 'set backs,'" and goes on to say that he will endeavor to point out that Run, Repair or Transfer will retard instead of facilitate the movement of the loaded car. I have failed to find a single paragraph in the paper where Mr. Kleine proves that Twentieth Century Inspection will retard the movement of the loaded car. The paper goes on to define the necessity of inspection, quotes freely from the M. C. B. rules and comments on failure to live up to and enforce the individual rules.

If the M. C. B. rules cannot be enforced then there must be something wrong with them, and the next thing to ascertain is, what is it that is wrong and after finding that out apply the remedy. He deplores the making of special agreements. We fully agree with Mr. Kleine in this stand and that is one of the things that the advocates of Twentieth Century Inspection wish to abolish and in order to do so make the rules so that special agreements will not be necessary. This, however, cannot be accomplished as long as the M. C. B. rules permit the inspector of the receiving line to be the judge as to whether a car is safe to run or not. So long as rule 2 reads as at present, just so long will cars continue to be set back and interchange points blocked by the switching of cars to and from transfer tracks regardless of any steps that may be taken by the car owner to put the car in good physical condition before loading.

Mr. Kleine does not advance a single argument in favor of the interchange of cars on M. C. B. rules that is not advocated by every advocate of Twentieth Century Inspection. We want the delivering line, when a car reaches its terminal and before it is delivered to the receiving road, to see that the car is inspected and repaired, but once it is set on the transfer track of the receiving line we want the receiving line to take the car and either run, repair or transfer it, but take the car or its contents they must. This we consider a good business proposition.

The advocates of Twentieth Century Inspection do not for a moment advocate the delivering of broken down or wornout cars as one would be lead to believe from reading Mr. Kleine's paper. If the delivering line does deliver cars in a wornout and broken down condition as stated by Mr. Kleine, Rule 15 of the American Railway Association steps in and protects the receiving line from the cost of transfer. The writer of the paper also claims that the receiving road will have their yards blocked with Bad Order cars, cars improperly loaded, or not equipped to meet safety requirements. That might be true if the loaded cars were all going one way, such, however, is not the case. No one road has a monopoly on loaded cars, unless at certain seasons of the year the number of loaded cars practically balances going in either direction, so that I cannot see where there is any cause for alarm from this source; it is purely imaginary. To prove this, all that anyone has to do is to spend a few days at any of our large terminals and check the interchange of equipment between the different roads.

In commenting on cars taken on record Mr. Kleine makes the statement that interchange tracks between railroads are sometimes ten to fifteen miles apart. This is one of the strongest arguments that can be advanced for Twentieth Century Inspection. After the delivering line has taken a train of cars ten to fifteen miles from its yards and placed them on the track of the receiving Company and returned to their own yards and then has to go back and take possibly fifty per cent. of these cars back ten or fifteen miles to their own yards for repairs, certainly does not look like good business, and is a movement of freight for which there is no return to the Railroad Company, in fact is a dead loss and helps to reduce the profits of the Railroad Company, not to speak of the delay to the freight in reaching its destination. How much better to have the car taken into the yards of the receiving line in the direction of its destination and there repaired or transferred as the case may be, and save that ten or fifteen miles of haul besides 24 to 48 hours' delay in reaching its destination. Probably nine-tenths of the cars rejected are for small technical defects. As the M. C. B. rules stand today with the provision that the receiving line shall be the judge there is practically no limit to the defects for which an Inspector can reject the car.

If the M. C. B. rules in their present condition are all that the advocates of them claim, why is it that practically every large interchange point in the country today has adopted local rules that keep the loaded car moving.

I personally know of a large interchange point where there was a local agreement to keep the loaded car moving. Some of the parties to that agreement decided to withdraw, thinking they could reduce the bad orders, and transfer of loads by so doing and to handle the interchange of cars strictly in accordance with M. C. B. rules. Their withdrawal from the local agreement broke up the organization and all roads agree to interchange cars on the basis of M. C. B. rules. I spent two weeks in that terminal and they were the busiest weeks of my life. We never had such a blockade in the history of that terminal before, and I hope never will again. It became so bad that the Managements of the roads took a hand and the road that was the first to withdraw from the local agreement was also the first to call a meeting for the purpose of making a new agreement to keep the loaded car moving.

Mr Kleine dwells on the receiving road's responsibility for cost of transfer. I cannot see that there is any cause for uneasiness from this source. Rule 15 of the American Railway Association covers this part so thoroughly and so well that this can be eliminated from the question of the Twentieth Century Inspection entirely.

In conclusion Mr. Kleine submits a basis on which he thinks that cars should be interchanged so as to maintain the safety of the car. We agree with every one of them except No. 6. Instead of making local agreements providing for the repairs to defective cars, etc., as outlined by Mr. Kleine, we would change Rule 2 of the M. C. B. Rules to read: "Loaded cars must be accepted, the receiving road to either run, repair or transfer."

Very truly yours,

WM. BAIRD,
Supt. Shops.

NEW YORK CENTRAL & HUDSON RIVER R. R. CO.

Buffalo, N. Y., April 20, 1910.

Mr. C. W. Alleman, Secretary, Railway Club of Pittsburgh, Pittsburgh, Pa.:

Dear Sir—I beg to acknowledge receipt of your esteemed favor under date of April 15th, whereby you kindly enclose me an advance copy of a paper to be read before your Club Friday evening, April 22nd, by Mr. R. L. Kleine.

Would respectfully advise it was my full intention to try and be present with your Club on the date in question to listen to this very important paper and the discussion thereon. However, finding this will be impossible it will be my pleasure to outline a few comments on the same.

It would be fulsome talk to say that Mr. Kleine is not entitled to a great deal of commendation for so ably presenting a question before the country at this time of such vital importance, and it is my desire to offer the same to Mr. Kleine through yourself as Secretary of the Pittsburgh Club.

In going through the paper somewhat rapidly there are one or two points brought out by the author that appeals to me directly, in so far as interchange methods are concerned, and those are the car owners' responsibility as laid down in our present M. C. B. Rules, and the reference thereto by Mr. Kleine, as to the proper observance of the same throughout the country.

We all realize in these busy days that the owner's defects on freight equipment have been of inestimable value in expediting the movement of freight, and the writer has no hesitation in stating that owner's responsibility as the future demands are practically one and the same issue and should be brought as a paramount question before all clubs and officials to warrant their adoption for the best interests of traffic, and preserving the high records of railroads in this country. As a matter of explanation to sustain this argument, we must confine our thoughts to the increased severity of the service from all points of view within a few years past, and we all realize that the owners' defects have not kept pace with such changes.

Another important item noted by me in the paper is the objection raised by Mr. Kleine to the so-called notation record in vogue at some large interchange points, and the writer feels that everyday experience with this question would have a tendency to convert those opposed to the method, that it is far better for the interchange to allow freight equipment to go forward with a large number of defects that will never be repaired, than to placard the cars with defect cards and take up the time of the interchange inspectors to the exclusion of more important defects. This statement may appear somewhat strange, but it is based upon personal observation and personal experience in the past and the present.

I have no desire to go further into this paper other than to remark that Mr. Kleine, as well as all other leading railroad men directly connected with the interchange of equipment, is doing a valuable service to the community as well as the railroads in bringing out the different sides of these questions for discussion and thought.

Yours very truly,

W. O. Thompson,

Division Master Car Builder.

St. Louis, Mo., April 20, 1910.

Mr. C. W. Alleman, Secretary, Railway Club of Pittsburgh, care P. & L. E. R. R., Pittsburgh, Pa.

Dear Sir—Allow me to extend to you my appreciation for the advance copy forwarded to me with your letter of April 15th, on the subject of "Interchange of Freight Cars on the Basis of Master Car Builders' Rules of Interchange vs. Run, Repair or Transfer," by Mr. R. L. Kleine, Chief Car Inspector, P. R. R. Co.

After carefully reading the points so ably presented by the above-named gentleman, I wish to state that this booklet is exceedingly interesting and affords considerable food for thought, and in my opinion it is necessarily a duty each and every mechanical and transportation officer owes to the position he occupies to express his convictions gained from experience in order to bring about a betterment of service, and through such voicing of opinion only can uniformity be accomplished in the interchange of cars. Mr. Kleine clearly illustrates that the Master Car Builders' Rules are not being lived up to at the various interchange points on account of local agreements having been entered into, somewhat deviating from the Master Car Builders' code.

Now, considering that there were no local agreements entered into between lines at large terminals, and Master Car Bunlders' Rules in their entirety prevailed, leaving all discriminating power in the hands of car inspectors, and considering that no two inspectors, acting in a similar capacity, are the same in their inspections, their rejection and acceptance of equipment, due, in their opinion, to various classifications of defects, that their line do not feel justified in accepting, and such defects are so numerous that it is almost useless to enumerate. It has been clearly demonstrated on tests made that no two car inspectors going over the same train, each taking his individual record, will make a fac-simile reports of defects existing on cars inspected. Considering this as the point in view, what guarantee would the delivering company have that cars examined by their inspector prior to delivery, would be accepted by the receiving line; and then stop to consider, as an illustration, that in one particular locality some twenty different railroads centered at that point, and there exists an intermediate line to perform switch service, may I ask is it possible or practicable to attempt to interchange cars at such points except by entering into some special agreement between lines accepting the Master Car Builders' Rules as a foundation, and adding thereto such additional rules as is necessary to prevent the unnecessary handling of equipment and further prevent consequential damage?

Now it must be further admitted that at all large terminals where switching is performed that 90 per cent. of the damage created is attributed to this class of service, due partly, if I must say so, to the lost art of making use of the hand brakes on cars, and in addition the various conditions of handling and classification of equipment. It has been the undersigned's opinion that in localities where mechanical representatives continue to uphold the Master Car Builders' Rules as their basis of interchange without any additional understanding or agreement between lines, such points could not undergo a close investigation without developing some deviation from the Master Car Builders' Rules, and if such could not be found, then hazardous conditions must prevail in the untold unnecessary handling of cars and creating additional damage to commodity in transit as well as equipment. The writer is speaking from actual experience of interchange of cars under the Master Car Builders' Rules, some several years ago, and I assure you all lines centering in this locality cannot afford to again attempt a similar experience in interchanging cars under strictly Master Car Builders' Rules, still we must all admit that the Master Car Builders' Rules are a grand conception of brilliant minds and required many years to perfect in establishing standards and placing responsibility between owner and handling company, but we do feel so long as we are engaged in the interchange of cars in this section, that the Master Car Builders have not as yet gone far enough in their perfection of rules to guarantee the continuous movement of cars, thereby preventing unnecessary detention, and in order to accomplish such the Master Car Builders must remove from their rules any and all penalization, for the reason that to perfect the acceptance of cars tendered in interchange, particularly such carrying commodity in transit. We must not place a premium on account of certain defects existing, but instead compel the owner to assume the responsibility for the ordinary handling of cars, as is outlined in the

Master Car Builders' Rules, regardless on whose rails repairs may be made. If in all sections of the country it was possible to closely affiliate the officials of the transportation and mcehanical departments as to the everyday necessity of some improvements needed in the rules of interchange of freight cars between lines, it would not be long before necessary official power would soon be forthcoming, and then uniform adequate rules would be adopted befitting all localities. Therefore, I would recommend that the Master Car Builders extend their every effort in the reorganization of their rules of interchange and procure such data from men experienced in this particular class of work to further guide in perfecting rules to fit the present existing conditions.

In regard to the question of defective cars in transit wherein the Master Car Builders' defect cards should be applied before delivering to connection, and at such points where there is no joint inspector or chief joint inspector. It is almost impossible for the delivering company to card a car satisfactorily for the receiving line, particularly at such points where the traffic is exceptionally heavy and in order to guarantee the correctness of such issuance of cards and see that they are placed upon the car, the delivering company would necessarily have to incur additional expense by maintaining inspectors, not only for the receipt of cars delivered to it by its conecting lines, but also to follow cars delivered by it to connections in order to prevent the receiving line rejecting on account of car not having defect card. I would recommend that at all large terminals that a system of joint inspection be installed with sufficient officers to cary out the full intention and purposes of the rules in that locality. By so doing Master Car Builders' defect cards would be issued only after personal inspection, as I previously explained above, owing to the fact that no two inspectors will take a fac-simile report on cars bearing certain defects, further illustrates the necessity of arbitrator or representative to act for both companies in question. Experience has proven this service as most satisfactory to all concerned.

It is a foregone conclusion that the necessary reorganization of the present Master Car Builders' Rules will at all times be objected to by many mechanical men, due principally to lack of educating themselves in the needed requirements of car interchange rules, and in answer to them who would criticise others who have given every thought for the betterment of service in forming associations at various points and entered into special agreements in order to reduce to minimum the delay to traffic, do so evidently for the reason that they have not made themselves conversant with the facts that brought about such mutual associations, and to prove this I have but to refer you to any of the large terminals as far West as Denver and East to the Niagara frontier, who have adopted joint service and special agreements. And it further goes without saying that necessity was the foundation of creating such organizations, and adding to the Master Car Builders' Rules such rules as was found necessary to move the traffic through its various connections, and by procuring the very best talent from these various organizations as a representative committee to express their opinions from experience gained before the mechanical representatives, who continually express themselves that the present Master Car Builders' Rules of Interchange are good enough, would, I am sure, somewhat enlighten them on future needs. The opinion of the undersigned is that in most instances the mechanical representatives' objection to joint service and the participating in same can be traced to the zealous motives, fearful of losing a portion of their official power. Therefore, it will require broad-minded men with experience in the interchange work before we can expect the perfection of interchange rules.

Speaking on the subject of betterment as to the classification of equipment I can only say that in line with recommendations of this character that the future will have to develop itself, taking into consideration the individual actions of the owners of equipment as to the necessity of betterment. It is also true that the so-called steel underframe cars are by no means up to perfect expectations. Many of them are as complete a failure in the design of construction as many of the old wooden underframe cars; and in fact some of our old wooden underframes are superior. Considerable credit must be given to the broad-minded mechanical engineers who have accomplished the wonderful results in steel underframe cars, but there are so many classes of steel underframe cars that the result of so large a failure in ordinary handling demonstrates the need of closer affiliation of mechanical engineers completing their tests before placing such equipment before the railroad world, if they consider this as part of the later improvements supposed to have been made in car construction. We have little to look forward to for some years yet to come as to perfect car construction equal to the service they are being put to. Consequently, rules befitting present conditions is essential and the future will take care of itself in car construction.

Referring to the subject of transfer in order to perfect an equitable rule that would be befitting to all conditions and still make the delivering company responsible. In my opinion such a rule, fairly speaking, would be unjust, and I claim that any and all rules that have been accepted assessing liability against the delivering company is unjust. For the reason the delivering company originating the load and having hauled it over their rails and delivered same upon the tracks of the receiving company, have duly performed their portion of the service and it is up to the receiving line to either transfer to equipment that in their opinion is satisfactory for movement over its rails or repair car. Whenever we attempt to designate that on account of some physical defect existing on the car as a warrant sufficient to cause delivering company to stand the expense of said transfer, regardless of whether or not the defect would justify transfer instead of repairs, when we attempt to formulate a list of defects that would constitute transfer against the delivering company, in order to make all rules of transfer uniform, we find that in computing tables of this kind, to try and fit the occasion that it is also impracticable, for the reason that it would not prevent sharp practice that may be attempted by the receiving line in recording old defects that in no way impair the safe movement of the car, and, as I have previously stated in another article, that it would be impossible and irrelevant to dare attempt to formulate a transfer rule assessing liability on delivering company, during dull and prosperous times. It can be seen at a glance that during dull periods railroads prefer, on account of economical reasons, to use their own equipment and save per diem, while during the prosperous times and the shortage of cars is considered, every consideration will be given to repairs, in order to keep cars moving. Mr. Kleine intimates the possibility of encouraging the continued loading of defective equipment, provided the receiving line had to assume the transfer, but if the delivering company had to assume the transfer it would prevent the continued use of such cars. Facts, however, do not bear out Mr. Kleine's contention, for the reason that statistics have been gathered for the month of November, 1909, on this very subject of transfer, which is very interesting, giving a detailed account as to various causes for transfer and signifying whether the receiving or delivering company pays. The report shows that at the St. Louis terminals twenty-one lines report a total of 877 cars transferred out of a grand total of 117,570 cars interchanged, the receiving line assumed the cost of transferring 780 cars and the delivering line 97 cars. St. Louis rules provide protection to receiving line on cars having defects denoting unfair usage, as per Master Car Builders' Rules 49 to 56 inclusive, all cars bearing defects under these rules, delivering company pays. While the Chicago statistics show that reports from twenty-eight lines, a grand total of 209,731 cars interchanged, 2,162 of which were transferred at the expense of the receiving line. According to their agreement the expense of transferring is borne entirely by the receiving line. It simply develops into a question of give and take and removes all narrow-minded suppositions.

Under the head of necessary shop facilities, the mechanical departments of railroads are, without question, lax, either for the want of sufficient official power or dilatory in the application of necessary repair shop facilities at large terminal interchange points, in order to meet, without delay, the continued growing needs of repairs to equipment, for, in most instances, machinery and material necessary to properly perform the work can only be found at their main shops, generally located as near the center of their main line as possible, making it necessary to haul defective cars hundreds of miles, creating additional untold damage to equipment. The present facilities offered to the outlying repair shops is simply a makeshift and results in unsatisfactory work—plainly speaking, patch jobs. The sooner our mechanical representatives wake up to the actual needs of the car department, particularly at large terminals, in order to overcome the conditions that now exist, the better for all concerned. Our transportation officers are becoming enlightened moreso every day by educating themselves in the interchange rules, and at most all large centers they are taking active part in the formation of necessary rules. The writer recalls that not many years ago active interest by other than mechanical officers would be considered interference, but soon the tide turned and the management of various lines abolished the Mechanical Association on Interchange Rules and placed the entire interchange of cars in the hands of the Superintendent's Association, and I am frank to admit that through this latter organization the rules are carried out most admirably and to the entire satisfaction of all members. It is further known that other large railroad centers are similarly handled and continually extending its power by creating necessary uniform interchange rules adaptable to conditions under joint supervision. In conclusion I would recommend that we all join hands and utilize energy for the betterment of service.

Owing to my inability to accept the invitation extended by the officers of your club to be present at your next meeting, wherein the subject of car interchange will be discussed after the reading of Mr. Kleine's very able paper, I take this means of voicing my opinion on the subject. Thanking the members of the Railway Club of Pittsburgh, I remain,

Your respectfully,

J. J. O'Brien.

MR. ARTHUR HALE: [Communicated]—I am glad that the advocates of a strict construction of the Master Car Builders' Rules are so close to the men who are advocating "Twentieth century" inspection, and I trust that the discussion of Mr. Kleine's paper will show that there is little difference between them. There is a misunderstanding between them, but I feel that this can readily be cleared away.

Mr. Kleine's conclusions certainly will be accepted readily by the most advanced advocates of a quicker movement and a simplification of the Master Car Builders' Rules. The men who are advocating the principle of "run, repair or transfer" are advocating it with the idea that everyone will play fair, and also with the idea that rigid interpretations and the wholesale setting back of cars will not of themselves improve the design of cars nor enforce the Master Car Builders' loading instructions.

It is undoubtedly desirable for roads to retain the right of refusing cars of unsafe construction and of placing an embargo on improperly loaded cars, when experience has shown that such improper loading is the result of a persistent and wanton violation of the M. C. B. Rules; but police measures of this kind need not be pressed so far as to interfere with the free movement of loads.

As Mr. Kleine states, local agreements providing for the repairs to defective cars and adjustment or transfer of lading without the return movement of the cars, are necessary and desirable. Mr. Kleine limits such agreements to *local* agreements. As I understand the position of the advocates of the "Twentieth century" inspection, they desire the Master Car Builders' Rules so changed that local agreements shall not be necessary at so many points, and that when such local agreements are made they shall be as uniform as may be.

I will not give advice to men of experience in the Maintenance Department. My experience in that department has been too small to warrant it; but I feel that the existence of special interchange agreements at so many points is an indication that something can be done, and done by the Master Car Builders' Association, in the direction of uniformity in such arrangements. I understand that there are at least twenty local arrangements which have been formally agreed to at different points in the country, and we all have personal knowledge of many more agreements of a less formal character, but equally binding. These agreements always provide for a quicker movement of the loaded car; they usually provide for joint inspection. I cannot but feel that the situation would be improved if the M. C. B. Rules were so framed as to cover the good points now covered by local agreements.

MR. JOSEPH DYER: [Communicated] The papers of Mr. William Baird, Shop Superintendent of the C., B. & Q. R. R., and Mr. W. O. Thompson, Division Master Car Builder of the N. Y. C. & H. R. R. R., respectively, read before the Western Railway Club and the Central Railway Club, on the same subject as that of the able paper presented tonight by Mr. Kleine, each suggest radical changes to the present interchange rules.

I was particularly interested in that part of Mr. Thompson's paper in which he gave his opinion that at a future date a suggestion would be necessary making the car owners responsible for all repairs required to keep their cars in service, either loaded or empty, no matter under what conditions the repairs became necessary, as a similar suggestion for recommendation to the Arbitration Committee was made about ten years ago to the Master Car Builder of an Eastern Line with a recommendation that the owner be recompensed by an increase in the amount paid for the use of the car. The suggestion was not put to the Arbitration Committee.

Mr. Thompson also recommended the organizing of a corps of traveling inspectors whose duties should be to see that all roads maintain a common standard of materials and workmanship on all cars of all roads. I believe Mr. Stark made a similar suggestion at one of our last year's meetings and evidently still holds to the same idea.

The rules now in force governing the interchange of cars covers about everything and it seems to me the only weakness is in the rule which makes a road responsible for a combination of defects caused by the weakening through decay or breakage, of a single part of the car for which the owners would be responsible if repairs had been made before other damage occurred, and it is that weakness which make the suggestions of Mr. Thompson the more valuable.

Cases happen where a receiving line refuse to accept a car with a defect which possibly would result in a combination of defects for which the handling road is responsible, yet the same inspector would run a car belonging to the road employing him, or a car already in its service, with precisely the same defect. If all cars should have the loads transferred owing to a single defect, such as a cracked end sill, which is liable to lead to a combination of defects for which the handling road would be responsible the expense of transfering loads would be a very heavy burden.

Any arrangement which might possibly lead to loose inspection at loading points would, in my opinion, be against the interest of the originating road but of all the roads over which a shipment is to be moved as loose inspection means probable accidents and addition the shipper and consignee both suffer in the delay of their freight. Such an arrangement would also increase the trouble of the freight claim people, as it has been my experience that a transferred load usually means a claim for shortage or damage. The per diem charges, incidental to the delay of the car in the transfer of the load, must also be given consideration.

We can readily understand the necessity of having the receiving line run or repair the car or transfer the load at Chicago, where the interchange track of the receiving road is ten or fifteen miles from the yard of the delivering road, as the delay to freight would be too heavy if freight was returned, and the switching expense would also be very heavy. Like arrangements would be profitable at other interchange points where the conditions are the same as at Chicago, but to force the responsibility and expense of transfer on the receiving line, where conditions are about equal as to delay, hardly seems right. The expense of transfer should be a penalty, but it would not be a penalty, but an imposition, to charge such expense to the receiving road.

No exception can be taken to Mr. Kleine's remarks about notation records, as the notation record system not only puts an unfair amount of work where it does not belong, but unnecessarily increases the clerical work in car department offices and in car record offices.

MR. ROBERT B. RASBRIDGE: [Communicated] I submit the following in support of the very excellent paper by Mr. Kleine, and in view of the lengthy discussion and the many written expressions, will endeavor briefly to emphasize some of the strong points of M. C. B. Rules versus "run, repair or transfer." This subject has received considerable attention and ventilation, and further serious thought is necessary before submitted for final decision to the M. C. B. Association. At first thought the run, repair or transfer would appear to be a solution of past or present troubles. This, like dew, however, vanishes when brought in the sunlight, and the disadvantage of the R. R. T. multiply. The M. C. B. Rules as to responsibility appears to be safe, conservative and liberal; it also provides for the care of cars while on foreign lines to a very great extent. From year to year they have been greatly modified and owner's responsibility increased each time when it was found advisable or necessary to do so, and the coming year will bring changes along the same conservative lines. Radical action or changes should not be encouraged and responsibility for damaged equipment should be confined to certain limits, as at present—derailments, wrecks, unfair usage and greater combinations penalizing the road handling the car, which naturally avoids to a great extent damage that would follow without any restrictions whatever. Car service rule 15, of the American Railway Association, is the result of methods tried out in the interest of prompt handling or delivery of cars, and considered the most desirable in the interest of all concerned, but it has its dangers and eliminates safety provision at the initial or loading point that result in delays en route. We are all one great railroad family, but not of the same railroad, and the greatest good to the greatest number of cars must be considered. The idea of R. R. T. is advocated in the interest of the interchange business and avoidance of delays generally, but it is like the cart before the horse, it starts the car out with troubles and certain delay that should and can be avoided before it is loaded; in other words, the trouble is transferred to the other fellow. A provision is suggested that loaded cars must be accepted at interchange points without regard to their condition, and if not in serviceable condition the receiving road to run, repair or transfer.

The fundamental principles of the M. C. B. Rules should be encouraged and upheld. The R. R. T. is in strict violation of same, and not in accord with the spirit of the Interstate Commerce Commission inspection. Roads so situated as intermediate lines fed on both sides or both ends, naturally would have its freight rate exceeded by the cost of transfer, "which appears to be a hidden and running-mate of the R. R. T.," causing a loss, and surely prove a hardship on the receiving line, which would rightly belong to the delivering line, and arouse suspicion that naturally attaches in the loading of defective cars. We are all aware of the advisability and desire for quick movement of cars and the R. R. T. operates against it, from the fact that it delays the car en route, while the M. C. B., preserving the rights of the car owner and car user, insures quicker interchange if the originating road applies proper care in the selection of suitable cars to carry the load to destination. It is true the M. C. B. Rules make the receiving road the judge as to what they will accept, and the wisdom of this is apparent when you realize what it would mean if your grocer, butcher and tailor could decide what you would eat and wear. Is it not a fact that too little interest is taken in the education of inspectors up to a standard of what is safe and good judgment, and is it not the practice very often for the interchange inspector to place his judgment superior to the M. C. B. Rules, in view of local conflicting agreements. This probably accounts in a large measure for the delays at terminals and transfers that is charged to the M. C. B. and which rightly could be charged against an R. R. T. arrangement. Again, this R. R. T. naturally would lead to great difficulties when yards are congested, and relieves the delivering line of the car and per diem charge as well. Is this fair and just to the receiving line? It would also encourage sharp practices which the M. C. B. Rules prohibit and frown upon; it will result in careless inspection and impair the general good of all cars; it allows cars in service that properly should be sent to the shop for repairs, this service leading up to hardships on neighboring lines that strive to keep their equipment in good condition, and are forced, as it were, to take a chance that would result in serious loss or troubles. Imagine the expense and possibility of claims for damage or loss which are not unusual in case of transfer. Is it not true we have too many cars in interchange business that are unfit for service and should be withdrawn? Local agreements in conflict with the M. C. B. Rules can be considered responsible to a great extent for present conditions of cars, and it would seem advisable that they be discouraged in the interest of quicker and better service. The fundamental principles of the M. C. B. Rules should be conserved and still followed, and the liberal policy extended in combinations and owners' defects.

PRESIDENT: Has any gentleman here anything to say after all this? We will be very glad to hear from him.

MR. E. A. KNIGHT: Mr. President, I fully agree with the author of the paper, that the M. C. B. Rules of Interchange are preferable to the proposition that we run, repair or transfer.

The latter arrangement would seem to me to open a door whereby everyone would seize the opportunity to unload his bad order cars on his neighbor.

On the road with which I am connected we have very little interchange in the Pittsburgh district, except with our own divisions.

A number of cases have come to my notice where inspectors have found cars under load that were in a general bad condition. However, not having reached the danger point, they were considered able to deliver the lading, and were, therefore, marked "Shop When Empty," and shoved along to the other fellow. The other man, however, takes a different view of the matter, and in looking up the billing finds that the destination is perhaps the Pacific Coast, and it is up to him to run, repair or transfer.

Therefore, we believe that if the run, repair or transfer proposition was made general it would create more trouble and confusion than we are now experiencing with the M. C. B. Rules.

The rules as they now stand fully cover the repairs and interchange of cars if they are strictly complied with and construed intelligently.

The author of the paper lays down in seven paragraphs, under the head, "The Necessity of Inspection," the fundamental principles necessary for the movement of cars with safety.

This brings up the point where we require the services of a car inspector. It also suggests the thought that to carry out these fundamental principles he should be a man competent to not only inspect cars for safety, but to determine whether the general construction is of sufficient strength to be handled in heavy trains, that the physical condition is O. K., that the safety appliances are in proper repair, that the lading is properly placed and secured, and that it does not exceed the clearance limits of the road or division which it is to go over. He must also be familiar with tank car construction and know that they are according to specifications and requirements. He is required to be familiar with the American Railway Association and Interstate Commerce Commission rules and regulations governing the transportation of explosives.

It would, therefore, seem that it requires a pretty big man to be a successful car inspector, and, as a rule, the compensation is not sufficient to make the position attractive for competent men.

We, therefore, do not get the full benefit of the M. C. B. Rules on this account.

I do not think our troubles at interchange points are due so much to the M. C. B. Rules as to the manner in which they are handled.

PRESIDENT: We have with us Mr. T. L. Burton, General Mechanical Inspector of the Central Railroad of New Jersey and Philadelphia & Reading Railroads. Can we hear from him?

MR. T. L. BURTON: The statement has been made that a man who talks before the Pittsburgh Railway Club had better be careful of what he says, unless he wishes to be called down by someone who probably knows more about the subject on which he attempts to speak than he does himself. With that thought in mind I made a few notes this afternoon on the parts of the paper upon which I anticipate an occasion to speak this evening. Before referring to these notes, however, it probably would be well to state that I have never endeavored to pose as an expert car man or as an expert on rules of interchange. However, in carefully reading the paper of the evening, it occurs to me that Mr. Kleine has so clearly and so specifically pointed out the many advantages of interchanging cars on the basis of M. C. B. Rules rather than the run, repair or transfer method, that it would not require an expert to endorse the position which the author has taken.

An interchange business of any character involves the necessity of some means of checking the commodity offered in interchange in order that responsibility for shortage or damage to such commodity may be justly placed, thereby minimizing the losses and damages occurring in interchange, which, so far as concerns car movements, means a protection against rapid deterioration in the physical condition of equipment, to say nothing of placing the financial responsibility for the frequent damage to cars in transit and at terminals.

The contention may be made, justly so, perhaps, that a rigid enforcement of the rules under which we are supposed to interchange cars, will work a hardship on some of the parties to the rules, but the fact remains that if through the enforcement of these rules a hardship is encountered, through delay to traffic and cost of repairs, the burden will be borne by the ones to whom the delay and expense justly belongs, viz: the delivering line on which the damage is done.

As a rule, the time required to make certain car repairs and the cost of same will vary in direct proportion to the time elapsing between date of repairs and date of damage, if, of course, the car is in service meanwhile, and in the majority of cases it naturally would be in service under the so-called system of "run, repair or transfer," otherwise nothing would be gained by such a system, and as the repairs must eventually be made it is not clear to me how car movements will be expedited by simply transferring the point of repair.

Moreover, the adoption of such a system would place the burden of repairs upon those who are desirous of maintaining equipment to a suitable degree of efficiency, or stated differently, the indifferent car owner would be in position to, and probably would, practically close their car shops, and in so doing depend upon others to maintain their equipment, which, after all, would not be such a burden to the road upon which a car repair force might be maintained, were it not for the tactics which are frequently employed by indifferent roads in picking technicalities in repair bill—in fact, in questioning between the lines the honesty in rendering a bill for legitimate repairs. I have in mind one case where certain large car owners questioned the bill of a receiving road for repairs to two retaining valves, on the grounds that the owners did not find it necessary to repair so many valves in one month.

My experience has been that car owners, by which the least attention is paid to the maintenance of equipment, are the ones who object most seriously to paying for repairs to owners' defects.

The roads with which I am connected maintain several joint inspection plants and at some places where deliveries are made by long transfer movements, receiving companies are supplied with delivering company's defect cards, for use in connection with defects which occasionally develop in transfer—such points are conducted, however, on strictly M. C. B. basis, and while many advantages are derived therefrom by avoiding long "set-backs," as the paper terms it, there is no disposition on the part of any of the connecting lines to deliver cars in accordance with what the paper terms "run, repair or transfer" system.

In my judgment the adoption of such a system will, as the paper most ably and correctly states, result in a rapid detioration of equipment, to say nothing of ultimately retarding rather than accelerating car movement.

In further support of that part of the paper which refers to the "run, repair or transfer" system encouraging deterioration of the cars, it might not be out of order to state the experience of one of the roads with which I was connected during 1908, when on account of the depression in business everybody was reducing expenses as far as was in keeping with the requirements of the service. One of the largest roads in the country was delivering cars to us in a most deplorable condition, to which the car owner's attention was called, and in a number of cases they made a proposition to us that we make such repairs as we thought the car needed when delivered to us and they would do likewise when they were delivered back to them. But we readily conceived that thy did not consider that any repairs were necessary and we would be the losers by such an agreement. The result was, sufficient pressure was brought to bear on the owner of the cars to place them in safe condition to run and the result has been a marked improvement in the physical condition of the equipment, quite to the contrary of what we would expect if the receiving road had been compelled to accept the cars regardless of condition.

Unfortunately, the characteristics of men in railway service, as well as other branches of business, is to do a liberal portion of their work on paper.

It is the height of some terminal men's ambition to show on paper that they can do a job one-tenth of a per cent. cheaper than their neighbors on the next division, while in reality the so-called cheap man may be the most expensive one on the system. Such policies are not always handed down by heads of departments, but in many cases they eminate with local men, of which car foremen, foreman inspectors, and, *possibly*, yard masters, etc., are not always exceptions.

The use of hump yards have accelerated and, in many cases, reduced the cost of yard movements, probably at an increased cost for repairs. The man who handles cars down a hump, or the man under whose supervision they are handled, hates, worse than anyone else, the occasion for disturbing the makeup of a train after it has been classified—especially if doing so necessitates shoving a car back over the hump in order to get it to the shop or repair track, for the double movement increases the cost of drilling and usually means a delay to train movement.

The adoption of a system of interchange, making it compulsory for connecting lines in or near hump yards to accept cars regardless of how they may be damaged in classifying, will place in the hands of drill crews at hump yards a club for breaking up cars, rather than for holding them on grade. This statement is not made by way of criticism to those who have the general welfare of their company at stake, but it is based upon the characteristics or weakness of human nature, which frequently causes a man to place a higher value upon his individual record than he does upon the financial interest of the company by which he is employed.

In the contribution of the gentleman from Nebraska, which has just been read, the statement, or rather the confession, is made that the "run, repair or transfer" system, of which he is a strong advocate, would impose a hardship and injustice upon the receiving roads were it true that such roads received more loads than they delivered. But he defends the proposed system of interchange by saying the load and empty movements are practically the same in all directions, which is equivalent to saying any road delivers as many loads to connecting lines as it receives from connections.

Such a statement may apply to roads in Nebraska, where the author of the statement is located, but it does not apply to heavy coal-carrying roads in the East, especially those having tidewater outlets.

I can see where the "run, repair or transfer" system could be used to some advantage by the roads with which I am connected, at points where we deliver to New England connections. But the moment we saw fit to abuse the system to an extent which we would be in position to do, where would the New England roads get off? They would have to accept the load from us and after discharging the load at tidewater and offering the empty cars back to us for movement to the mines, we would be in position to reject the cars if defective. It is true, however, that we discharge the bulk of our coal at the water fronts in the vicinity of Philadelphia and New York. The same is true of other roads in Pennsylvania and New Jersey, and as a large percentage of this coal is received from connections having no water outlet, to which we deliver practically nothing but empties, we would be compelled, under the proposed system of accepting the load instead of the car, to accept anything our connections should see fit to send us and they, receiving practically nothing but empties from us, could reject everything, thereby blocking us with defective equipment.

Objection was also made to the receiving road being the judge as to the safe condition of equipment offered in interchange. If a tramp should apply to the author of that statement for a night's lodging, I dare say the head of the household would not waive the privilege of judging the tramp's qualifications and fitness to spend a night under his roof. In this case the delivering company would have no voice in the matter.

It occurs to me that your Club would not go far wrong in endorsing as a whole the paper of the evening, or placing yourself on record as condemning what is termed "run, repair or transfer" system of interchange.

PRESIDENT: Mr. T. H. Goodnow, Master Car Builder of the Lake Shore & Michigan Southern, ought to be able to give us some information on this subject.

MR. T. H. GOODNOW: Mr. President and Members of the Pittsburgh Railway Club: As I am practically a stranger to this Club, and not having been forewarned as Mr. Burton, I am rather intimidated by his introductory remarks and shall, therefore, be very cautious in what I say, so as to take no chances.

It is difficult to discuss so able a paper as Mr. Kleine has presented this evening, especially when one so thoroughly agrees with it so that no argument is raised in your mind on which to take issue. The question of "run, repair or transfer," as it is generally discussed, appeals to me as one that is confusing, and for those having to deal with the M. C. B. Rules of Interchange they should divorce the transfer proposition from same. The M. C. B. Rules are established for the protection of the physical condition of freight equipment, and as such in their present form are intended to keep cars on their forward movement when offered in interchange, by making defects either owners' responsibility or cardable, so that there should be no hindrance to the forwarding of cars up to where the question of safety becomes involved, on account of cars being in bad order, and when they either have to be transferred or repaired, the M. C. B. Rules being in no way responsible for this, and here is where the transfer question enters.

In this connection, those of us who are responsible for the M. C. B. Rules of Interchange are not for the Transfer Rules, and I maintain that it should not be permitted or necessary to make any reference to this feature in the M. C. B. Rules, which are intended for the physical condition of cars. We do not control the load or the handling of it, and the responsibility rightfully does and should rest with the traffic or transportation officials who originate and handle this matter, as to how such loads shall be disposed of when necessary to be transferred when cars interchanged and unsafe to go forward, and any rules established to dispose of this should not interfere with carrying out the M. C. B. Rules so far as they apply to the car itself, as I believe they can be applied after the load is disposed of. It seems that, owing to the conditions varying so at the large interchange points in different parts of the country, it is almost impossible to make a uniform rule, covering the transfer feature, acceptable to all terminals and railroads, especially for the reason that the movement of loads both ways in interchange is not equal, which often places the transfer expense all on one side. If a broad, uniform rule for handling the transfer feature of loads in interchange could be established it would put this question on the same basis as the M. C. B. Rules for the protection of the physical condition of the car, which are made for the country at large, and with no exceptions on account of any local conditions, treating all alike. On account of the transfer conditions, it has resulted in individual rules being applied as best to suit local conditions at the various large interchange points, and in drawing up these special agreements, included in them, have been certain rules abrogating the M. C. B. Rules, such exceptions being made probably for the purpose of facilitating the handling of the car at such local point, and in this losing sight of the broadness of the M. C. B. Rules established for the sole purpose of protecting the car owner at large. I believe it is possible to maintain the integrity of the M. C. B. Rules, applying them in connection with the transfer question, which may differ and not be uniform, and still not violate the main object of the M. C. B. Rules, that of protecting the car owner.

I am from Chicago, and I will say that there the interchange is handled on the run, repair or transfer basis, the load being accepted and not the car, if unsafe. The receiving line transfers at its own expense. After transfer, if the car is your own, you repair it; if it belongs to the delivering line you return the empty. The one benefit to be derived from the receiving line paying the cost of transfer, in which probably the M. C. B. Rules of Interchange can be involved, is that it puts it up to the receiving line as to just how rigid they will be in their inspection and cutting car out for transfer, knowing they will have to stand expense of same. If the delivering line is paying the transfer expense, one is apt to take advantage, especially if he has a very bad car or load delivered to him. Under the other you are going to put either car or load in shape, and, for the car, bill owners, or, on authority of defect card, if repairs are made.

As stated before, I believe the inception of this question run, repair or transfer is wrong, and that the transfer feature should be divorced out of it and not conflicted with the M. C. B. Rules, which are to accomplish their own individual purposes. Another point which has been made by those advocating this is to modify the M. C. B. Rules making owners responsible for practically everything, with which I do not believe any of us should agree. To allow roads to handle cars without any responsibility as to their condition would be to have such cars, when becoming in unfit condition, on account of bad order, shoved on to someone else, and under this scheme the freight equipment would soon be its own evidence against any such conditions.

PRESIDENT: Mr. F. H. Stark, of the Pittsburgh Coal Co., is in the immediate foreground. Can we hear from him?

MR. F. H. STARK: Mr. President and gentlemen, as has been stated, the author of the paper has presented the subject in such a manner that it is difficult to criticise. I presume that there will be difference of opinion as long as there are different men. As to the author's remark in the forepart of this paper on the question of safety inspection, on the first impulse we might consider that a personal matter with each road, and the car owner or connecting line has no concern with the question of safety on another road. But, on giving the matter a little thought, it will develop that we are vitally interested. While it is true that the conditions and requirements differ on different roads, yet in a general way they are pretty much the same. For instance, suppose the management of a road instructs the mechanical department to reduce the cost of inspection and the number of repair men. The consequent standard of safety on that road would differ from that on the Pennsylvania. Yet the Pennsylvania cars are running on that other road. The road handling the cars concludes to run its own and foreign cars with certain minor defects, and from the fact that such initial defects are not repaired, consequential damage occurs that the owner is responsible for. For example, a road may consider it practical to run a car with two draft bolts broken, regardless of location. The car is placed into a train and the end is pulled out, and the owner is responsible, except, of course, where the combination is exceeded. Can it be fair to a car owner for a road to take chances and cause consequential damage and charge it to the owner? There is a little consolation perhaps in the fact that you can charge for quite extensive repairs to the foreign car owner, but the other fellow is returning the compliment to the full measure, and the result is that the cost of maintenance of railroad cars is climbing up year by year. I believe that it is time that we should consider whether there could not be a uniform practice brought about as to inspection and what is safe and what are unsafe defects. How can that be accomplished? The chief car inspectors at all the large terminals should have their jurisdiction extended, not only to settle the question of safe condition of cars that are offered in interchange, but they should represent all the roads not only in that particular territory but all over the country, and it would be the duty of such joint inspector to see that all the roads in his territory are living up to the same rules as to standards of safety.

It might be contended that the chief inspectors might differ in opinion. We should have annual conventions at which the chief joint inspectors should get together and discuss these problems and in that way have more uniform action all over the country. In addition to that I would have traveling inspectors who would have authority to demand access to the shops and offices of all railroads, and any road found violating the rules ought to be made liable in somewhat the same manner as the Federal government does regarding safety appliances.

I appreciate that at Chicago it is almost impossible to have every car inspected and a defect card issued by the delivering company, because their yards are so far distant. If we had a joint inspection system or joint inspectors in general, the notation card could be considered. As it is now, to pass a car on notation it requires a great deal of correspondence to secure the offset card and that is the objection to the notation system. If you place a notation card on a car, it would be interesting to know on what per cent of such notation cards there is a demand for a defect card. The natural tendency would be that the owner would remove the notation card and ask for a defect card. On securing the defect card they would be tempted to render a bill for repairs not made, although it would be contrary to the M. C. B. Rules. If we were all as honest as our friend Kleine we would have faith in each other and allow the receiving company to apply the delivering company's defect car . But unfortunately we have not employed men of the caliber of Mr. Kleine and if the notation card is attached to the car it calls the owner's attention to it and he naturally will ask for a defect card, and, in turn, when he gets the defect card he is liable to render a bill for work that was not done. If the chief joint inspector or other general inspector had authority to visit all railroad yards and detect railroads that were demanding a defect card and making bills for repairs not made, and they could be penalized in some way, it would soon break that up; in such event the notation card would be a move in the right direction.

Mr. Kleine refers to the owner being made responsible as encouraging better design. There is no question but what that is true. But I believe we have carried the owner's responsibility far enough to cause the owner to improve the design of its equipment if it is faulty. They are now chargeable with broken couplers and draft timbers and essential parts to the draft gear. But suppose we remove the delivering company's responsibility and make the owner responsible for practically everything, as suggested by Mr. Baird, if I understand him right. Just as soon as you increase the owner's responsibility you increase the rough handling of cars. Nearly every road accepts as fair handling on the part of its train or yard crews, any combination of defects that the owner is responsible for. The result is that the transportation department does not question a crew that damages a car, providing it does not exceed the owner's responsibility. The consequences are that cars are being handled roughly and the cost of repairs is increased accordingly. Gentlemen, can we remove the delivering company's responsibility altogether and not increase the cost of maintenance of cars? You all remember when a draw bar was broken the crew was called in and perhaps suspended or reprimanded, at least. But today if two longitudinal sills are broken in a car there is nothing said about it. If the couplers are broken on both ends of the car, there is nothing said to the crew. The result is that cars on most roads are handled roughly.

With regard to hump practice, if all the roads would conduct that like the Pennsylvania does at Altoona there would be less damage done to cars than in ordinary flat surface cars. But, unfortunately, all the roads do not employ enough men to ride the cars and they are allowed to drift down by gravity at various speeds. I cannot understand the argument of Mr. O'Brien when he states that during dull periods the receiving road would take advantage and charge the transfer to the delivering company. If the condition of the car is in accordance with the M. C. B. Rules I do not see how the receiving road could charge for the transfer. Furthermore, if there were a chief joint inspector or some arbitrator, he should decide the question as to who should pay for the transfer.

I am not speaking from the private car owner's standpoint. I have been railroading for so many years that I have never lost sight of the railroad company's interest. And I believe that the car owner is made responsible for all the defects that can occur under fair handling. I believe the mechanical department will have to take a more active part. We are yielding to the transportation official's demands. Anything to expedite the movement of cars regardless of cost. If you require the delivering company to accept all cars, you put the burden of providing capital for facilities on the receiving road. He must provide the material and labor to make the repairs and wait three or four months for repair bills to be paid. The receiving road must pay for the per diem on the cars delayed for repairs and they are subject to claims for damage on account of making the transfer, and the temptation would be to run the cars in the condition they are offered, and, as Mr. Kleine has stated, it does not require any prophet to anticipate that the condition of the cars would deteriorate. Mr. Kleine has very clearly pointed out that roads can make special arrangements for repairs to cars where a road has better facilities, also for waiving the per diem on cars delayed awaiting repairs, so that practically all the advantages in the chief joint inspection arrangement at large terminals can be accomplished, as outlined by Mr. Kleine, just as it is today, and at the same time observe the M. C. B. Rules and protect the car owner, and expedite freight rather than retard it. It appears to me that the mechanical men will have to assert their position and regain their rights. Not that I fear that some of us old fellows will be shelved, but if the mechanical men do not come to the front and offer some solution, it will not be long before the car men will be reporting to the agent or the yard master, and his position will deteriorate just about as the cars will under run, repair or transfer.

PRESIDENT: We would like to hear from Mr. Boutet, Chief Joint Inspector at Cincinnati.

MR. H. BOUTET: Mr. President and Members of the Pittsburgh Railway Club: I desire to extend to Mr. Kleine my congratulations on the paper he has presented here this evening.

I heartily agree with him on some of his propositions set forth, but on others, I am afraid, I will have to radically disagree with him.

To make sure that every one will understand my position, I will quote you from my address to the Chief Joint Car Inspectors and Car Foremen's Association of America, of which I have the honor to be President, at a meeting held in Buffalo in September, 1909:

"There is no question but that the M. C. B. Rules have been the only means by which the railroads of this country have been enabled to transact the business of the continent, and without them it would be imposible to conduct the transportation that is necessary to carry the different products of any portion of the country to the markets of the world, but the M. C. B. Rules are based on honesty, and it is absolutely necessary that each and all of us use every endeavor to maintain them in their entirety."

I think this is conclusive evidence that I am strongly in favor of M. C. B. Rules, but I cannot help but believe, especially in our portion of the country and at other large interchange points, that it is necessary to change the M. C. B. Rules to a certain extent to prevent the necessity of making additional local agreements, which it has been found necessary to do.

On examination of the local agreements at the different large interchange points, you will note that they are all very similar, which shows the necessity for some action to be taken by the M. C. B. Association to cover these points.

The first paragraph of Mr. Kleine's paper that attracted my attention was that he was an advocate of the interchange of cars with the least number of rejections, or so-called set-backs, in other words Twentieth century inspection, but that he could not agree on the run, repair or transfer proposition.

This certainly appears to me to be dividing the Twentieth century inspection, so far as it is known in our locality and in other large interchange points, as the Twentieth century inspection is termned run, repair or transfer.

This does not necessarily mean that the receiving line pays the cost of transfer, as at nearly all points outside of Chicago it is governed by American Association Rule No. 15, so far as the cost of transfer is concerned.

There are local rules, however, that provide that no transfer order will be given if the car can be repaired under load in ten hours' time of two men, or twenty hours, as per M. C. B. Rules.

I am free to say that it is about the only system, with our congested terminals, that would unable us to get the cars through with the amount of business being transacted. In fact, the General Yard Masters, at a meeting at Cincinnati, stated that it would be impossible to do the business that is being done under any other system.

The next paragraph in his paper, in which he names "ideal conditions," I am afraid that none of us will live to see such conditions prevail in this country.

It is a fact, however, that by far the larger portion of transfers are caused by defects that occur to a car after it has been loaded and by loads having shifted after being properly loaded, than are caused by defective cars being loaded or cars not properly loaded.

I quite agree with him that the inspection should be for safety and to determine the responsibility of defects to the equipment and the loading, as far as possible, but take the matter of inspection and responsibility of equipment, what a difference in interpretation and meaning of the rules is shown by the different roads and men employed by them.

In some localities some roads go so far as to class a facia board or roof board that has fallen off on account of having been improperly secured, a defect, for which the delivering line is responsible. Also broken end boards, when broken out, even when the end of car shows no combination, as, for example, a car with one end post broken out and two or three siding boards broken out, demanding a card for the end boards, claiming that this is not mentioned in the combination and it is rough usage and must be carded for, while the opposite is claimed by other points.

This, in my opinion, shows very plainly the necessity of having representative car men from all points to met annually to go over and discuss the rules and arrive at a universal understanding, and thus prevent different interpretations in different localities.

Regarding the failure to enforce individual rules, in which he refers to Rule No. 33, in which he states that some of the local interchange agreements decided to abrogate this rule, as they did not feel waranted to enforce same on account of the expense involved, notwithstanding that it was a safety requirement.

In this conection I do not know of any local agreements at any large interchange point in the country but what takes the M. C. B. Rules as a basis for their local rules.

The Rules of Interchange went into effect September 1, 1909, and I do not know of an interchange point in the country that demanded a card for wrong air hose until the latter portion of the year.

Regarding it being a safety requirement, I can hardly realize how a defect card put on a car, tacked on to the cross-tie timber, is going to prevent an air hose from bursting.

Neither can I realize if a railroad insists on purchasing air hose that do not meet with the requirements of the M. C. B. Association, and place same on their own cars and deliver same to another road, why the other road should be compelled to card those hose, making them responsible for the air hose.

It takes more time to inspect air hose on cars offered in interchange than it does to inspect the rest of the cars, and same is being done, causing the inspectors to overlook more serious defects on the cars.

I certainly agree with Mr. Kleine that the receiving line should be the judge as to the fitness of a car to pass over its line, but we have found for the delivering line to inspect all cars before delivery and see that all cars are safe to go to the repair or transfer tracks, and that all safety appliances are in good condition, does help the movement of freight through the terminals, as each car is shipped forward and there is no backward movement.

The matter of placing defect cards in the hands of all inspectors to card against the delivering line has proven an expensive proposition at all points where it has been tried. No matter what instructions and supervision is given in the matter, we find that there are a large number of cards given against the delivering line that should not be given. If you investigate this mode of inspection you will find cards on cars for defects that are imaginary or defects for which the owners are responsible.

There are thousands of cases where the inspectors in the receiving line yard will card for defects that you could not tell on looking at the cards whether it was proper to card or not, without seeing the cars. We should bear in mind that every car given is a check that cannot be repudiated.

Regarding tank cars, I believe that the tank car requirements, as adopted by the M. C. B. Association, are not any too rigid and all roads should live up to them to the letter, as there are quite a number of cases where tank cars do not meet the requirements as prescribed in M. C. B. Rules, but the companies, afraid of losing freight, will make certain modifications and permit the cars to run, the consequence is that one of these cars will come to an interchange point and cause a great deal of confusion and delay.

You will note in his conclusions that he recommends that all railroads and members of the M. C. B. Association take more interest in the rules of interchange and recommend practice of the M. C. B. Association.

While it must be admitted that the Arbitration Committee has always been composed of the brightest minds in the mechanical line, and they have some very complicated questions requiring considerable time and thought to settle, unfortunately, holding the responsible positions they do, they are not able to be on the ground and see the conditions that exist and note the changes and complications that arise in the interchange of cars each day, I believe that if, in recommending the changes in the Rules of Interchange, they would call in the representative men at the large points of interchange, and have the meetings cover enough time to have a full and free discussion on each rule, that by this means we would have a set of rules that would meet all the requirements of the large as well as the small interchange points and be satisfactory to both transportation and mechanical departments.

PRESIDENT: Mr. Turner, Superintendent of Motive Power, of the P. & L. E., is here, and we would be pleased to hear from him.

MR. L. H. TURNER: The Master Car Builders' Rules, as they stand today, are the result of forty years of study of some of the best practical mechanical men that have flourished during that time. Every member of the Master Car Builders' Association has the opportunity, if any thought presents itself to him, of suggesting it to the Arbitration Committee and that committee will certainly deal impartially with it. They do not legislate in favor of any particular railroad or territory. I am satisfied that the best way to eliminate notation cards, defect cards and delay at terminals is first to build better cars and then take care of them after you have got them. I have in mind a road that introduced a freight car repair pool a few years ago. It was no sooner in operation that every line and every division mechanical man exerted himself to get the cars onto the other fellow, and when they got to the end of their journey 25% to 50% of the cars had to be cut out for repairs. It was the easiest thing in the world to see the equipment going down every day. Finally they awakened to the fact that if they did not take care of their own cars no body else would.

Mr. Kleine has laid some stress on the honesty of mechanical men. Mr. Stark has referred to it. Personally I am satisfied that all the honest car inspectors and master car builders are dead. In self-defense I must say that it is not the heads of the mechanical departments that are dishonest, but always their assistants.

In the efforts of the M. C. B. Association rules to make loading safe, if they have erred in anything, they have gone too far in the direction of safety. I have the honor of being a member of the M. C. B. Committee on Rules for Loading Material, and there is no question in my mind but that some rules have been made and are still in force which are rather more stringent than is necessary. We must not forget that the large manufacturers have just as bright men working for them as the railroads and they are just as able to determine when a load is placed in a safe way and properly braced as we are.

Getting back to the question of honesty for a moment, we have been offered cars that did not comply with the M. C. B. Rules as to manner of loading, and we objected to taking them. They said, "All right, if you don't want them, your neighbors will be glad to get them." I do not want to take up time or mention any names, but Mr. Krause, of the Pennsylvania, is here.

PRESIDENT: I do not suppose Mr. Krause is the man Mr. Turner referred to who took the car he could not haul, but perhaps he would like to tell us about it.

MR. JULIUS KRAUSE: Gentlemen, there are two parties in the House of Congress and I am not surprised that there are two parties here. There always will be two sides. My friend Turner states the old honest inspectors are all dead. I have been inspecting cars for a long time, so I must be dishonest. My friend Baird, from Nebraska, certainly has some good ideas. You can't deny that. I passed through his State last summer and passed quite a number of his freight trains, and I must say I found no modern freight trains, from 50 to 75 loaded cars, but their trains were short and hauled by one locomotive, and, therefore, the draw-bar pull would not be severe on weak cars and their troubles would be less. The Interstate Commerce Inspector informed us not long ago he caught them out West cleaning the air brake cylinder and triple valve with white paint and brush, going over the whole train to get through quick. That is, "let George do the repairing."

When those cars reach us and we place them in 50, 60 or 75 car trains, as we all do, you know what defective air brakes will do; the emergency goes on and we pay the bill. The Western man says, "It is all right."

My friend, Mr. Boutet, from Cincinnati, who advocates the run, repair or transfer, so ably says he does not see what the standard air brake hose has so much to do with it, and yet he was given five years' time by the M. C. B. Rules to secure air brake hose strong enough and properly marked to stand the increased service on freight trains. While some buy hose strong enough to stand the service, others get the cheapest. In fact, they always like to buy cheap. He also states he does not see why they should place the M. C. B. defect cards on cars equipped with air brake hose not meeting the M. C. B. requirements.

A few days ago I had a report from our division and it showed 2,200 foreign cars reaching Pittsburgh during the last four months with one or two non-standard M. C. B. air brake hose on them and covered by M. C. B. defect cards, and quite a number of them came from Cincinnati. I do not know why he allowed the cars to leave Cincinnati.

These are our troubles.

My experience has taught me if you want to get freight to destination in the least possible time, you must load it in a freight car which is in good order and strong enough to stand the service in modern freight trains, and repair all defects promptly which may appear en route.

I served as car inspector for a long time, and when I visited Chicago several years ago I was very much interested by the way they inspected cars. The inspector was running along at the rate of four miles per hour; he had a piece of chalk and made a few marks on some of the cars. When he ran by a large car he called out the word "tunnel." I was told that the car did not pass clearance dimensions. The gentleman in charge informed me they had only so many minutes in twenty-four hours and so many cars to get through, and they certainly did get through. I was of the opinion they were trying to accomplish too much over one track.

I remember thirty years ago we could handle all the freight from the West through our small Pittsburgh yard, but as business increased the yard became too small and we had to construct tracks leading around Pittsburgh and build yards ten miles east of Pittsburgh, which remedied our trouble. Why not try the same remedy at Chicago?

At interchange points there should be some honesty. If a car is defective and the inspector finds the defect is safe to run, he should either make repairs or apply a defect card at once; this would remedy all the trouble. In other words, treat your neighbor right and he will treat you the same way. The people who are afraid that the other fellow is going to do them in every transaction, needs watching, as they have likely been in council.

My friend from Nebraska says that the steel car or cars with steel underframe is not holding up. I agree with him in that there are steel cars and steel underframe cars which are too weak. The mechanical engineer may have designed the car all right, but when bids were opened and it was found that $1,000.00 was asked, the mechanical engineer was told by his superiors that not more than $750.00 would be paid, and the result was that the steel car plant built you a $750.00 car. When measuring the center sill construction you will find 10½ square inches at body bolsters. This is the car that is not holding up and is giving trouble, and it will not stand the shocks and pulling strains in modern train service.

MR. T. J. O'DONNELL: Mr. President and gentlemen, I was directed to come here and listen to the discussion and keep mum by the chairman of our association, Mr. Thompson. However, after listening to Mr. Krause, I do not think we need have any fear for the future.

Coming down on the train today I read in the paper something about Mr. Klein, of Pittsburgh, and it occurred to me that I might not be able to leave Pittsburgh. However, I have heard Mr. Stark say that if all men were as honest as Mr. Kleine the country would be safe, so I presume we are all satisfied to live in Pittsburgh.

I think Mr. Kleine has brought forth a very valuable paper, from an inspection, an interchange, a construction and an operating point of view, and the gentleman is to be highly complimented by every person in the room. We must realize the fact, however, that we must disagree to agree and I have listened with a great deal of pleasure to the valuable information that has been presented here this evening. We have our Central Railway Club in Buffalo, but I must confess that it is an infant toward the Pittsburgh Club. The interest that is shown here this evening is certainly very gratifying, I am confident, to the officers and members.

I feel that all these special agreements that have been formulated at different places have been formulated with the very best intentions, and I feel confident that those officials have the best interests of the railroads they represent at heart. And I further feel that we, as the men who are placed in positions to interpret the rules, should be termed as servants of those officials and those railroads and not as dictators on any special rules that we may feel we have the right to cast reflections upon.

Then as to the spirit that should govern the different interchange points. We disagreed some 35 or 40 years ago when the North and the South clashed, but we have just as warm hearts in the South today as we have in the North, and I hope, Mr. President, that we as intelligent men will get together and feel that the operating officials will not dominate the car men, but ever will work in harmony for the best interests of transportation throughout the country that pay our bread and butter, that we have the wisdom and ability to earn. I thank you, sir.

MR. GOODNOW: Before Mr. Kleine closes I would like to say, as Chicago has been referred to(especially as to the adoption of A. R. Rule 15. It is not generally understood as to why that rule was not adopted. It was for the reason that the loaded movement of cars in Chicago is practically equal both ways. Not having a joint inspector or any similar system, there was no way to protect the issuing of transfer orders against delivering lines on bad order cars and that is the reason why A. R. Rule 15 was not adopted in Chicago.

PRESIDENT: Mr. Kleine, will you close the discussion?

MR. R. L. KLEINE: Mr. President and Gentlemen, in closing this discussion I will confine my reply to the criticisms of the paper brought out in the discussion on the floor, as well as those communicated to the Club by letter, and I will endeavor to clear up any points at issue by answering, separately, the various questions raised:

Mr. Baird states that he is not quite clear as to where I stand in the matter of twentieth century inspection and I will, therefore, briefly summarize from the paper as follows:

1. Strike at the root of the trouble and repair the defective car when empty and before it is loaded to the interchange point, instead of compelling the receiving line to receive the loaded car in any condition that the delivering line may see fit to deliver the car and by so doing provide an outlet for bad order cars under load and retard the movement of the load by the necessity of shopping the loaded car en route for repairs.

2. Base all local interchange agreements on the Master Car Builders' Rules of Interchange and do not abrogate or modify a single provision of these rules. This will define car owner's and delivering company's responsibility and will avoid disputes or the setting back of any cars for responsibility of damage to car.

3. Local agreements should provide where repairs shall be made to all cars requiring shopping, adjustment or transfer of lading without return movement of the car, based upon the facilities available where such inspection, repairs and transfers can be made. It should also provide against the forwarding to the interchange point of cars in defective condition, so that the repair and transfer at interchange will only be compelled to take

care of such defects occurring en route or in classification. Responsibility for repairs should be in accordance with the M. C. B. Rules of Interchange and responsibility for transfer should be governed by American Railway Association Car Service Rule No. 15. Transfer should be charged for on a basis of actual cost of doing the work, which must necessarily be dependent upon facilities available.

The question has been raised as to the difference between run, repair or transfer and what I term twentieth century inspection. As stated in the paper, roads working under the M. C. B. rules do not send back loaded cars, they accept them. But it is the understanding that the loaded cars will be delivered in fit condition to go forward and to accomplish this it is necessary to go back a little farther than the interchange point, and that is to the loading point, so that the empty car before it is loaded is placed in good condition, so that it will carry its load to destination without shopping en route. Of course where defects develop en route it is necessary that the car should be repaired. The advocates of run, repair or transfer seem to lose sight of the question of repairs to the car, or, in other words, the maintenance. Is the car going to be repaired by throwing the responsibility on the receiving line, or is it going to be repaired by placing the responsibility on the delivering company which interchanges the car? Simply transferring the responsibility for repairing the car to the receiving road certainly will not repair the car. It should be repaired before it is started out under load and the interchange points should only be compelled to do such work as develops en route. If we should adopt this run, repair or transfer proposition I am satisfied that a lower standard of maintenance of cars will result. What incentive would a road have to keep its cars in repair if they could deliver them to their neighbor in any condition of repairs? There would be none. If the receiving road demands a certain standard of maintenance the car itself will be placed in condition before it is loaded.

There is no question that the M. C. B. Rules can be enforced in every particular and the roads working strictly under these rules as they are modified by the Association from year to year to meet the changing conditions. It is the roads who have entered into local agreements abrogating part of the M. C. B. Rules who claim that the rules are unsatisfactory and believe there is a necessity for interchanging cars in accordance with run, repair or transfer system. Any special or local agreements should be what the term implies and not a change of the Master Car Builders' Rules of Interchange, inasmuch as no changes can be adopted locally without affecting the equipment of the entire country.

Mr. Baird takes the stand that the receiving line inspector should not be the judge as to whether a car is safe to run or not. If the inspector for the receiving road is not the judge I should like to know who would be the judge for the receiving road? The delivering road is certainly not acquainted with conditions on the receiving road and I do not believe the management of any railroad would agree to the taking away from them the prerogative of saying what car will move over their line. I maintain that this is a fundamental principle which cannot be taken away from the receiving line without impairing safety.

The statement is further made that probably nine-tenths of the cars rejected are for small technical defects. This, however, is not the case at interchange points working strictly under the M. C. B. Rules.

Mr. W. O. Thompson, of the N. Y. C. Lines, is in favor of extending car owner's responsibility and does not feel that the owner's defects have kept pace with the rapid strides of the service. The Arbitration Committee has been very careful in regulating owner's and delivering company's responsibility and has made changes from year to year consistent, I believe, with construction and demands of the service. He also favors the notation record with which I cannot agree. Place the defect card on the car where the M. C. B. Rules provide they should be tacked and thus avoid all further contention and separate records. Stop the notation record and cars will be maintained in better repairs to avoid the issuing of defect cards.

Mr. O'Brien makes the point that local agreements somewhat deviating from the M. C. B. Rules must be entered into in order to have inspection of the delivering and receiving line uniform. In the first place no subscriber to the M. C. B. Rules has any right to deviate from a single rule or modify any portion of the same, and in the second place nothing would be gained by doing so except avoid responsibility. Responsibility for defects or damage to cars should be no cause for rejection of cars; responsibility is clearly defined by the rules and all that is necessary is to have the inspectors govern themselves accordingly. I can see no reason why two inspections should be made of a car at an interchange point. A local agreement as to where this inspection is to be made, and with the defect cards in the hands of these inspectors, it simply remains to card the cars for the defects for which the delivering company is responsible according to the rules. This local agreement may require that there be one inspector for the receiving line and one for the delivering line working together on opposite sides of the car, or the inspectors may be joint men working for both roads interested, or in the case of a larger number of roads for all the roads interested. This will avoid all differences of opinion if the men are properly instructed and their work efficiently supervised.

Removing all penalization for damage to cars offered in interchange would directly encourage the rough handling of cars, which Mr. O'Brien so clearly portrays, and result in a lower standard of maintenance and resultant accidents.

The recommendation is made that the M. C. B. Association reorganize the Rules of Interchange and procure data from men experienced in this particular class of work to further guide in perfecting rules to fit the present existing conditions. This plan is followed yearly by the Arbitration Committee and if the rules are not what they ought to be we alone are to blame.

Mr. O'Brien points out very clearly the necessity of proper shop facilities at large terminals to take care of any bad order cars that may accumulate, as well as the necessity of preparing the equipment for loading of grain and similar commodities. He further states that the management of various lines have abolished the Mechanical Association on Interchange Rules and placed the entire interchange of cars in the hands of the Superintendents' Association. In this connection it must not be forgotten that the inspection of cars at interchange points is not alone to fix responsibility for defects, but for the more vital reason to determine whether the car is safe to move to destination. Mechanical representatives cannot adopt such measures which will block the movement but its arrangements to take care of the interchange and the safety of the movements should and must be joint with the transportation officers. I am glad to state that the road I am connected with has not taken the question of inspection of cars out of the hands of the Mechanical Department, but on the contrary holds the Mechanical Department responsible for the inspection and safe movement of cars.

Mr. Arthur Hale is under the impression that there is little difference between the advocates of the "Twentieth Century Inspection" and the gentlemen advocating run, repair or transfer, and in reply would refer him to the paper and answer to Mr. Baird's communication. Both sides are striving to reach the goal of a quicker movement and less detention at interchange points and I have endeavored to point out that this will not be accomplished by run, repair or transfer.

There is no endeavor on the part of the parties in favor of twentieth century inspection to enforce police measures and interfere with the free movement of loads, but on the contrary to have the car placed in proper condition before it is loaded and the load properly placed and braced on the car at the time of loading so as to insure its safe transportation to destination without the delay of shopping at interchange or en route inspection point.

As before stated, local agreements are necessary and as they should only cover the point at which the car should be inspected and where the repairs or transfer should be made, they cannot be uniform, but are dependent on the local conditions existing. There is no necessity of making local agreements on the M. C. B. Rules of Interchange, inasmuch as these rules cover the responsibility for damage or defects to cars and must be uniform throughout the country in order to be equitable.

In answer to Mr. Joseph Dyer on the subject of making the owner responsible for all defects irrespective as to whether caused by rough handling or not, I would refer to my reply to Mr. Thompson.

Mr. F. H. Stark seems to be an advocate of the notation record. I do not believe there is any necessity for a notation card. The defect card was gotten up by the M. C. B. Association to provide for certain defects. Why not place the defect card on the car, stop all further correspondence and tracing, and allow the car to go through if it is safe, and if unsafe, repair it and charge the cost to the proper party. Distance between yards is no valid reason for resorting to the notation record. Determine where the car is to be inspected, place the defect cards in the inspector's hands and have him make them out as required by the M. C. B. Rules of Interchange.

Mr. H. Boutet states that it is necessary to change the M. C. B. Rules to a certain extent to prevent the necessity of making additional local agreements, which it has been found necessary to do. It is surprising to hear these statements openly made in direct contradiction to Rule 130 of the Interchange Rules, reading as follows:

> "Acceptance or rejection of this Code of Rules must be as a whole, and no exception to an individual rule or rules shall be valid."

The railroads have subscribed to these rules as a whole and no officers of a railroad company, who are subscribers to these rules, have any jurisdiction to be parties to agreements which abrogate any of these rules. How can we determine whether the rules as a whole are satisfactory if individual rules are abrogated by certain parties? If there are any rules that cannot be complied with, and personally I do not know of any, the matter should be brought to the attention of the Arbitration Committee, supported by facts, and I am satisfied they would be speedily amended. An opportunity to do this is afforded the members of the Association annually.

Referring to the difference in interpretation and meaning of the rules among inspectors, Mr. Boutet cites as an example that some roads, in certain localities, go so far as to class a facia board or roof board that has fallen out on account of having been improperly secured, a defect for which the delivering line is responsible. There is no question in regard to this under the M. C. B. Rules, Rule 42 reading:

> "Material missing from body of cars offered in interchange, except locks, grain doors and all inside or concealed parts of car, delivering company responsible."

The M. C. B. Association very wisely penalizes a road for delivering a car in interchange with these parts missing, with a view of keeping them in repairs and avoiding accidents along the line of road. Can anyone cite a more dangerous condition than a facia board swinging out or a roof board sticking out from the side of a car endangering the lives of trainmen on the adjoining track? When these parts become loose, repair them at once, charge the owner and avoid further damage and possible accident.

Mr. Boutet further states that he does not know of an interchange point in the country that demanded a card for wrong air hose until the latter portion of the year. As a matter of information I would state that all the lines in the East working under the M. C. B. Rules and not under special agreement, demanded cards for wrong air hose and changed the hose beginning with September 1, 1909, the date Rule 33 went into effect. The air hose rule was made a penalty defect to enforce the M. C. B. hose specifications on all cars interchanged, with a view of insuring the hose on the car being at least up to these specifications and reduce the number of accidents en route from defective hose of inferior quality. Questions of this sort do not seem so important to interchange points, as they are mostly concerned with the trouble an order of this kind entails, but they are vitals from an operation standpoint.

If Mr. Boutet believes that placing the defect cards in the hands of the inspectors results in the issuing of a large number of cards that should not be given, and that if you investigate this mode of inspection you will find cards on cars for defects that are imaginary or defects for which the owners are responsible. I would respectfully invite him to make a visit to Potomac Yard, Washington, Jersey City or some of the other large Eastern terminals to satisfy himself that such is not the case. Where conditions, such as cited by Mr. Boutet, should exist it indicates a necessity for proper supervision.

Gentlemen, I thank you.

MR. C. E. POSTLETHWAITE: In listening to this talk tonight the thought came to my mind that there used to be an idea among transportation men that when all other obstacles in the way of a rush shipment had been surmounted that the car inspectors would surely find some rule whereby the car was not safe to go forward and it would have to be shopped or transferred. In such cases the transportation man had to adopt the "run" rule and get out of the way of the shippers most interested in the quick movement of the lading. Be that as it may, Mr. Kleine's paper, the letters received in connection with it, and the discussion which followed shows the subject to be a real live one. It is especially pleasant to see so many of our out-of-town friends here tonight and also to have them take part in the discussion. The large attendance indicates more than anything else the intense interest we all have in this subject, and gratifying as the large attendance is, I am sorry to add that many more came as far as the door but turned away because of the already crowded room, thereby emphasizing the necessity of our obtaining quarters where we will have more room to expand.

All the interest shown here this evening must be most gratifying to Mr. Kleine personally. I am sure it is so to the officers and members of the Club. Therefore, I move that we thank Mr. Kleine for his most interesting paper by a rising vote.

(Everybody rises.)

PRESIDENT: We are all up, Mr. Kleine.

ON MOTION, Adjourned.

In Memoriam.

FREDERICK MORTIMER ROBINSON

It is with deep regret that we have to announce the death of our much beloved member, Frederick Mortimer Robinson, who passed from this life on April 2nd, 1910.

Mr. Robinson was born in Petersburg, Va., in 1877 and attended school in Richmond, Va. Upon completion of his education he entered the service of the Chesapeake & Ohio Railway, and later, in 1903, became connected with the Sales Department of the Pressed Steel Car Company, Pittsburgh.

His short illness and sudden death was a great shock to his employers and business associates. We sincerely mourn his loss and his memory will be ever dear to his wide circle of friends.

C. E. POSTLETHWAITE,
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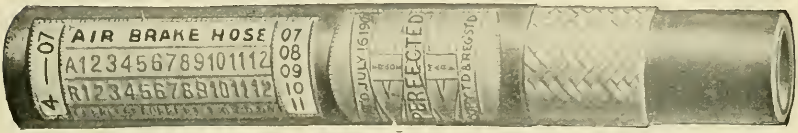

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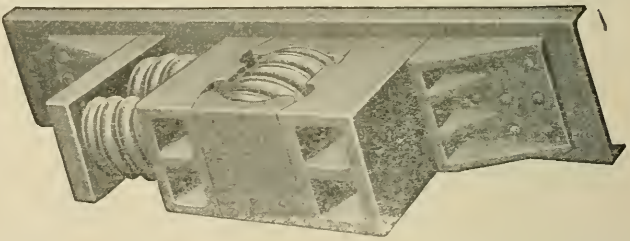

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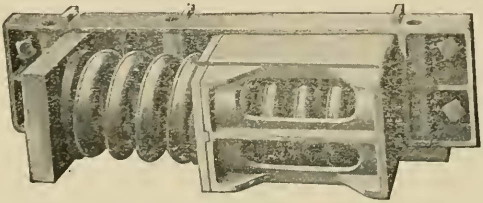

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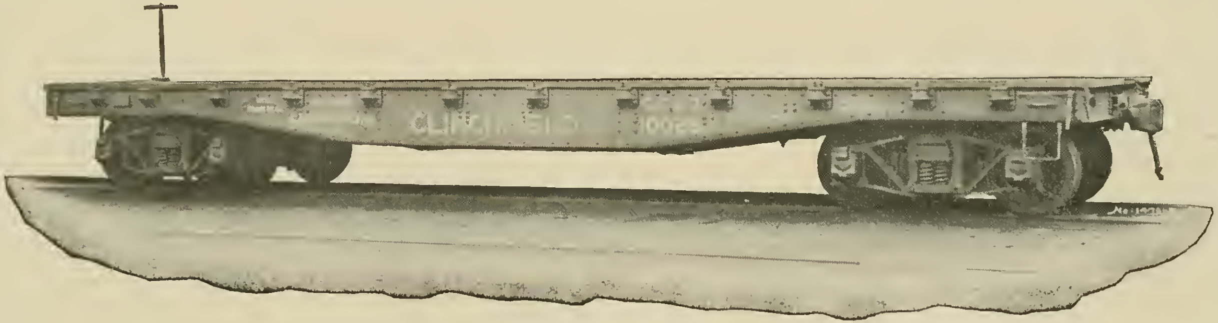

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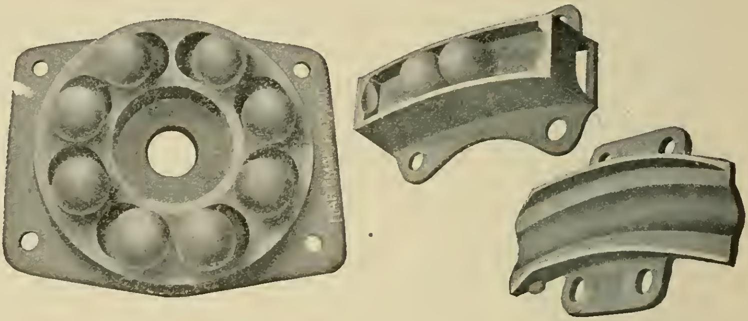

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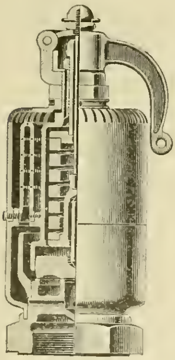

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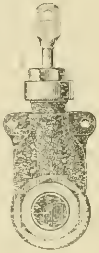

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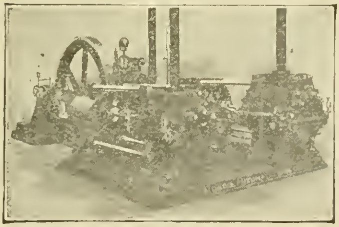

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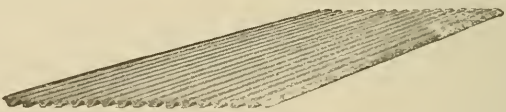

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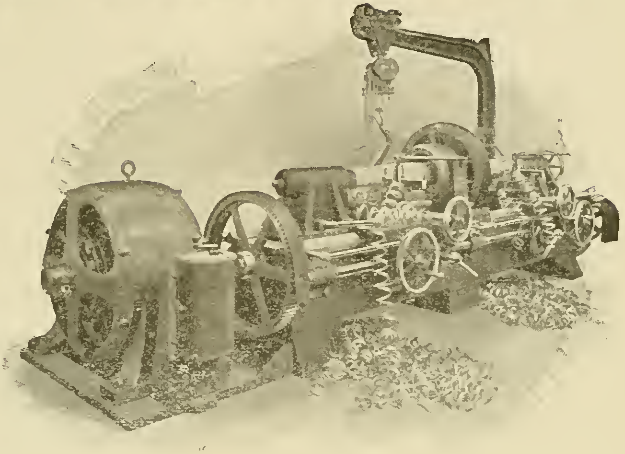

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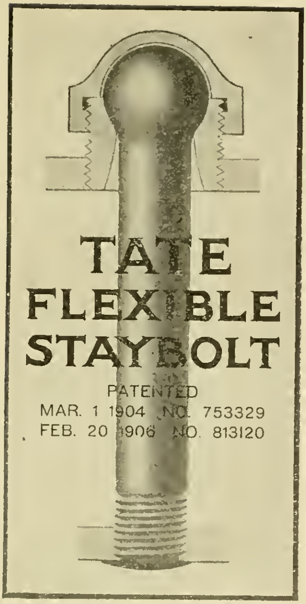

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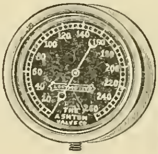

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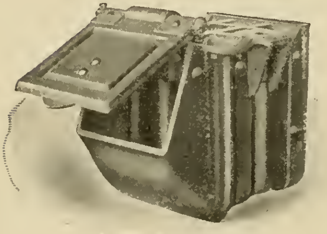

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING,
MAY 20th, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

The following gentlemen registered:

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The reading of the minutes of the last meeting was dispensed with, they being in the hands of the printer.

The Secretary read the following applications for membership:

Downing, I. S., Master Car Builder, L. S. & M. S. Ry., Collinwood, O. Proposed by J. W. McKeen.

Sims, J. C., Treasurer, Machinists' Supply Co., Pittsburgh, Pa. Proposed by Ellsworth Haring.

PRESIDENT: As soon as these applications have been favorably passed upon by the Executive Committee the gentlemen will become members.

If there is nothing further in the way of business, Mr. E. D. Dreyfus, of the Westinghouse Machine Co., will tell us about

"Present Steam Turbine Progress." I take pleasure in introducing to you Mr. Dreyfus.

PRESENT STEAM TURBINE PROGRESS.

BY MR. EDWIN D. DREYFUS, COMMERCIAL ENGINEER, WESTINGHOUSE MACHINE CO., PITTSBURGH, PA.

The attention of steam railway engineers has already been directed to the steam turbine of late years through the electrification of terminals and the use of the turbine in repair shops.

As the turbine industry has grown so rapidly, the development in the art of construction has been equally marked, exhibiting the dexterity of the designer to meet the increasing demand for large and efficient power generating apparatus.

In 1900 the largest turbine built in this or any other country was a 1500 kw. unit at the Hartford Electric Company, Hartford, Mass., while there are machines in service at the present time capable of developing ten times this amount of energy.

This installation was preceded by an installation of four 400 kw. turbines at the Westinghouse Air Brake Co., which was the first large turbine plant operated in America.

These views of early installations will typify the general features of the first machines constructed, and afford an interesting comparison with the improvements effected in the last decade in a particular build of turbine.

Types:

The distinguishing features of the various types of turbines have been made familiar in the many valuable papers that have been presented on this subject. One method of utilization of the steam by converting the potential energy in velocity and abstracting the velocity by rotating wheels, is used in the De Laval, the Rateau and the Curtis types, entirely; while in the Parsons construction, as now well understood, the work is performed through expansion in special shape blading, imparting the dynamic force to the turbine motor directly through reaction, by which term this type is usually designated. Furthermore, this effect is augmented by the action of the velocity produced in the stationary vanes in re-directing the steam upon the moving blades. The impulse type may be of the single or the multiple stage. On the other hand, the re-action turbine is inherently multiple stage, employing small pressure or energy drop, enabling the use of moderate blade speed for high efficiencies.

A significant fact not generally appreciated in the re-action type is that the blades are in form and effect nozzles. This feature is productive of high efficiencies which readily obtain in this type, as it has been demonstrated that nozzles range in efficiency from 90% to 95%, and blading from 60% to 80%. As the energy is absorbed in many stages in this type, it is least effected by any change in operating conditions, due to deficiencies in the auxiliary equipment.

Turbines differ largely from their predecessors, the steam engines, in that more consideration must be given the design for varying capacity and operating conditions, to obtain the best performance and mechanical structure, and at the same time conform with commercial demands.

In the engine, established standards, or frequently rule-of-thumb methods are followed, while the excellence of the design of the turbine in a large degree hinges upon the experience and ability of the designer. These factors have led to the combining of elements of two types of turbines in a single machine, as introduced in the familiar Westinghouse double-flow construction—a combined action and re-action turbine, now used to an appreciable extent abroad, as well as being adopted here.

Several different combinations have been applied, among which two types of impulse sections are employed, the high pressure element being a single-stage Curtis and the low pressure, multiple Rateau wheels, as practiced by the Allegmeine Electricitats Gesellschaft. Evidently the large sub-divisions in the low pressure range enables the more efficient abstraction of the energy in steam of large specific volume. For small sizes and steam volumes, the conditions are virtually reversed for all practical requirements.

Reciprocating Engines:

It may be inferred from the foregoing that from the present turbine outlook the position of the steam engine is further im-

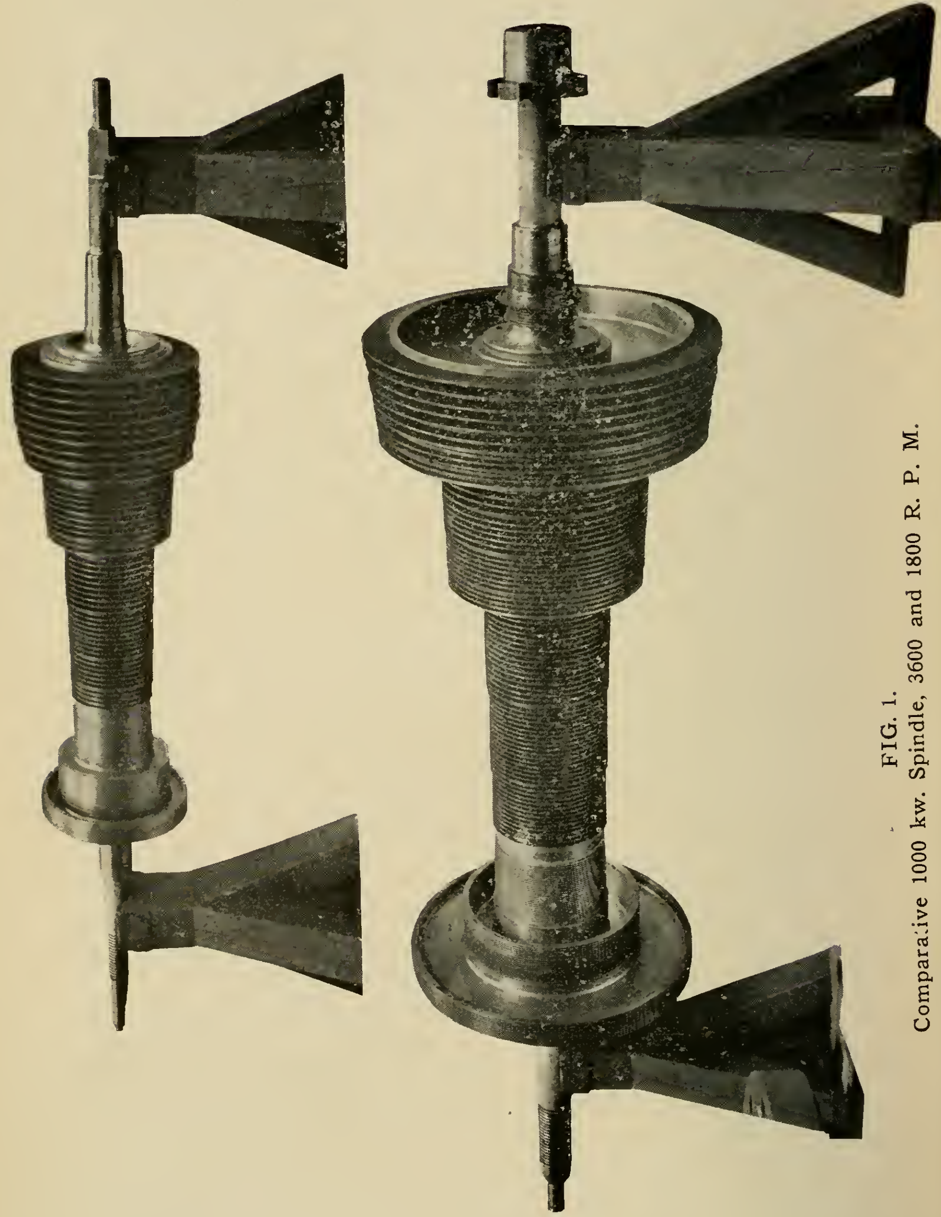


FIG. 1.
Comparative 1000 kw. Spindle, 3600 and 1800 R. P. M.

periled. This does not imply, however, that the reciprocating engine will be immediately displaced or superceded entirely, but the fact is nevertheless apparent that the field in which this type has been strongly entrenched (slow speed and reversing), is being rapidly encroached upon by the turbine through improvement in existing machinery and new inventions. Notably the adaptation of small generators, centrifugal pumps and blowers, the speeds of which have contributed to the more general use of the turbine.

A recent device of important bearing, is the Melville-Mecalpine reduction gear, capable of high powers and large reductions. Reversing turbines have now been made practical.

The above outlines the turbine aspect, and briefly summarizing, it has grown to be so important an economic factor for the following principal reasons:

(1) Less space; (2) decreased oil consumption; (3) better economy in the use of steam; (4) less attention and adjustments necessary, and (5) lower maintenance cost.

Where low fuel prices and heating requirements prevail, steam motors are more economical commercially than the internal combustion engine, and the reverse is true in the case of high coal cost and small heating.

Construction:

One of the more prominent developments in the turbine art has been the advance in speed rating made practicable by improvements in the turbine and generator art. This change is strikingly shown by the different construction at various periods of time.

The instructive paper by Mr. Leo A. Phillips on the features of the Westinghouse-Parsons turbine, in the 1907 Proceedings of this Club, makes it unnecessary to dwell now on any elementary principles of the design.

Regarding speed increase, the advantages may be appreciated in comparative views given in Fig. 1, indicating the relative dimensions of 1000 kw. turbine spindles for speeds of 3600 and 1800 R. P. M., respectively. Practically the same peripleral speeds are employed, and obviously with the smaller metal masses, ensuring greater integrity of casting, hence greater factor of

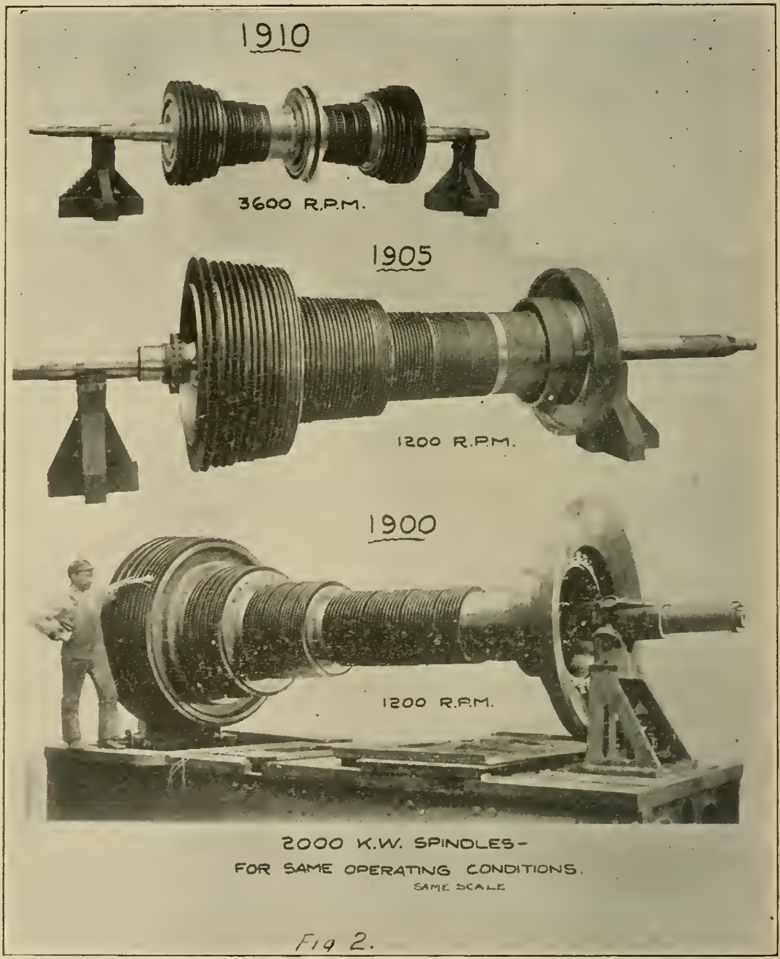
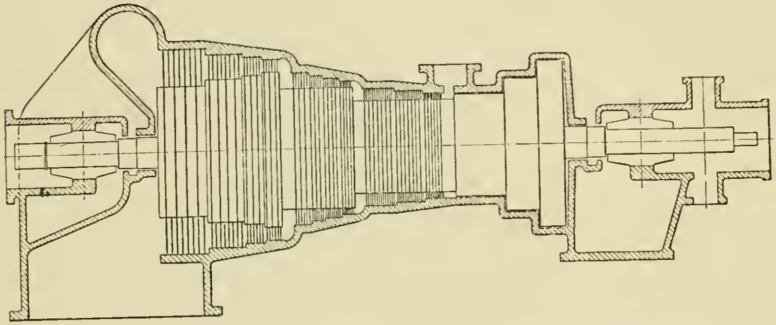


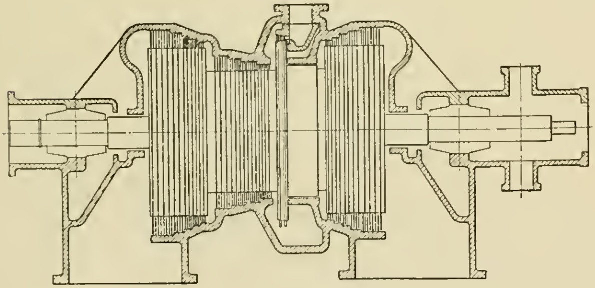
FIG. 2.
Progressive Development, 2000 kw. Spindles.

safety obtains in the higher speed machine. Another advantage accrues with the occurring re-distribution of steam, by which means a higher efficiency is secured.

An interesting exhibit of advance in both construction and speed, is presented in Fig 2, showing the spindle structure for the 2000 kw. turbine for periods five years apart. The oldest type was completed in 1900, and is more or less of a special nature. The last construction embodies the double-flow principle, feasible by employment of high speeds.



CONVENTIONAL SKETCH OF SINGLE FLOW TURBINE



CONVENTIONAL SKETCH SHOWING GENERAL ARRANGEMENT OF PARTS IN THE DOUBLE FLOW TYPE OF TURBINE

FIG. 3.

Relative Size of 5000 kw. Single and Double Flow Turbines.

When large powers are reached, the construction of the single-flow re-action turbine is encumbered to a degree by the existence of disproportionate exhaust ports and excessive distances between bearing centers. The design shown in the upper part of Fig. 3 induced the development of the double-flow arrangement appearing below it which retains the efficient Parsons blading in the low pressure element and substituting the less efficient high pressure element by an impulse wheel of practically the same efficiency, simply for mechanical reasons. The first machines of this type were built in 1903, and the latest construction presents a very symmetrical design. This type is very attractive in appearance, with well arranged valves and gears, as illustrated in view of complete unit, Fig. 4.

Similar considerations apply to the single-flow turbine as to the uniformity in design in Fig. 5 evidences. No type of multistage turbine is devoid of clearance (the nature differing only) and it is desirable to maintain small clearances in all cases, although not of necessity a large factor in the economy of the turbine.

Carefully observing the preceding views, the special features of the design are the symmetry of casting and unrestricted movement of expanding parts.

At the peripheral speeds re-action turbines are operated, the centrifugal stresses exerted at the root of the blade are relatively low and the method of caulking them in the spindle dovetail grooves provides a grip many times in excess of the forces acting to displace them. In fact, the blade will relieve at an intermediate section before being pulled out by the root. Securing the end of the blades is important only that it prevents nodal vibration and injury in event of slight rub. Firm holding of the tips is accomplished by comma wire lashing, which consists of a copper wire possessing a comma section, inserted in a similar shaped slot in the blade. It is then sheared over, forming a stout abutment between consecutive blades. An additional feature is that it occupies an extremely small portion of the steam space.

Turbines require less adjustment and attention than the reciprocating engine. Nevertheless, periodical inspection and care is necessary to re-set for any possible inadjustment. While the facilities are simple as in adjusting liners in the bearing blocks, greater accuracy must be observed than in the ordinary steam engine where considerable pounding and knocks may be allowed to exist. As the turbine operates so smoothly, it is sometimes en-

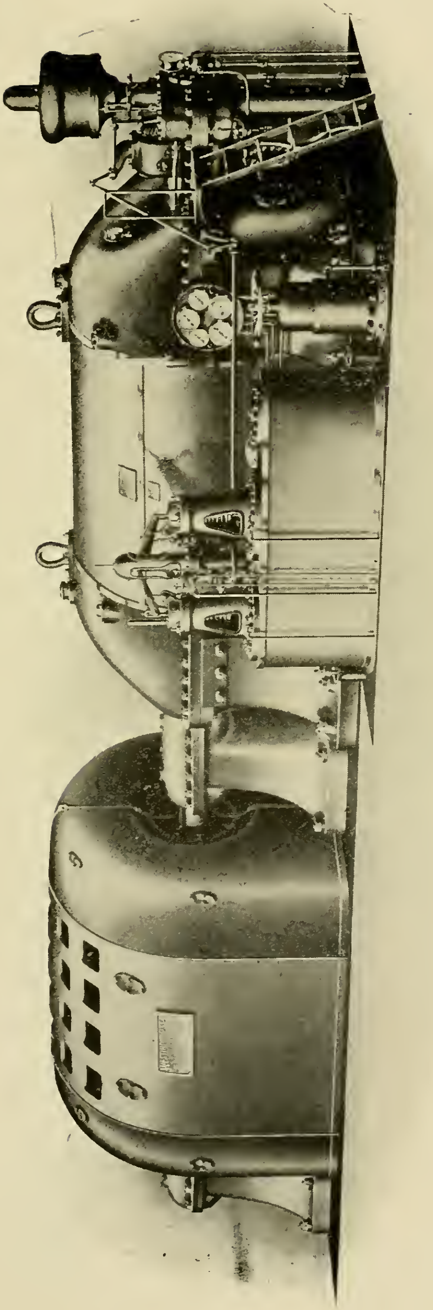


FIG. 4.
Westinghouse Double Flow Unit.

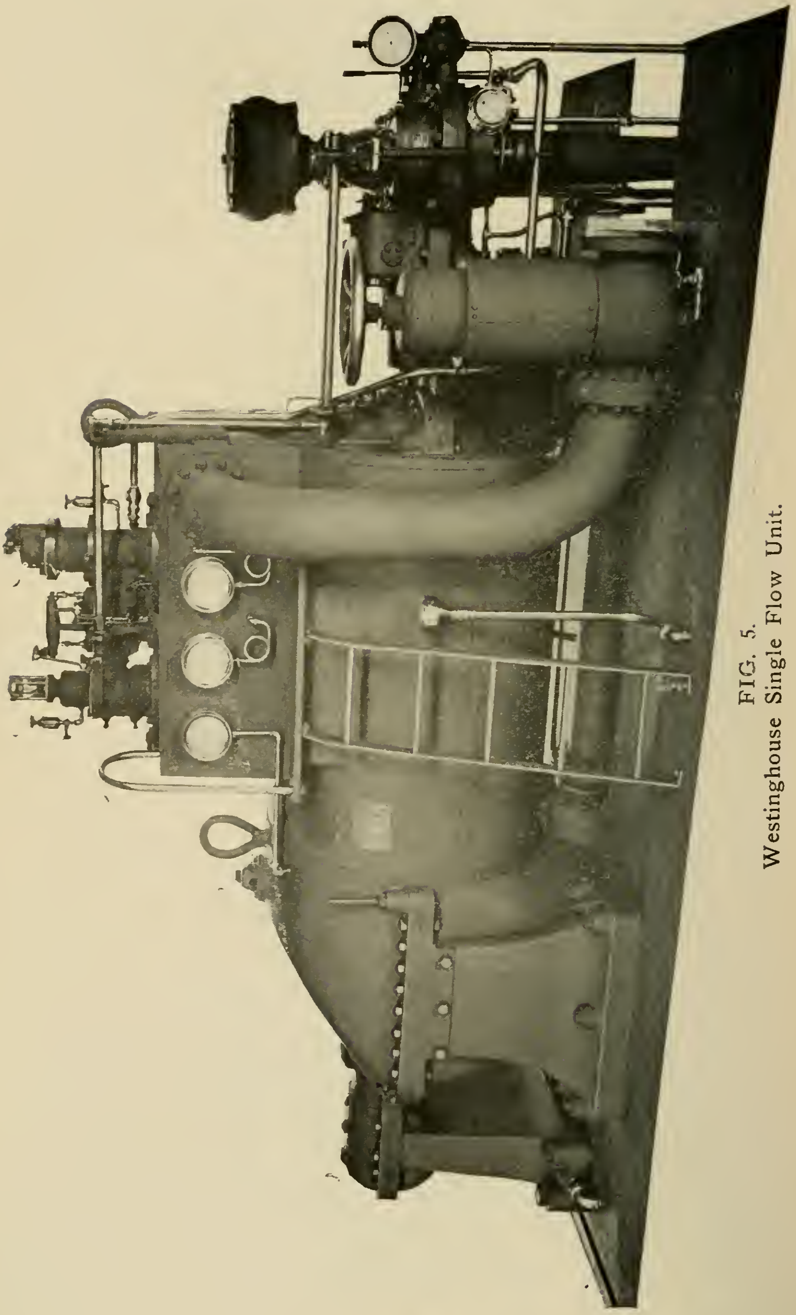


FIG. 5.
Westinghouse Single Flow Unit.

tirely neglected. It is known that the night watch on several occasions has slept and left the turbine to take care of itself. Besides, the accidents that occur are of no moment compared with similar cases of the engine. The large gain in the use of the turbine completely warrants the occasional service of a competent inspector or attendant.

It may be correctly stated that turbines came as a matter of necessity for the large size units. However, they are growing in importance in small sizes as well. In the latter case, the commercial conditions are different, involving lower efficiency and cost. Nevertheless, these are necessarily in competition with the small engines and must compare favorably or excel them in efficiency.

These are the factors that underlie small turbine work, and the design conforming to the requirement is shown in Fig. 6. This turbine is of the re-entry type, employing two velocity drops.

Operating Conditions:

Boiler pressures range from 125 to 225 lbs. gauge. In general practice 175 lbs. appears to be the best average for large capacities, as it is probably a balance of increased gain and investment for most cases.

Moderate superheat will undoubtedly prove most economical; that is, in the neighborhood of 100° F. While the apparent thermal gain (in the turbine only) is about 1% per 10 degrees, net results are very much less when the additional heat to be imparted to the steam and the extra cost of investment is borne in mind.

To illustrate, Fig. 7 has been prepared to show the net results to be expected. It is quite evident the range of maximum economic gain lies between 50 and 100° F. superheat. The higher superheat contributes toward lower steam consumption at the prime mover, but the over all plant results, which is the ultimate criterion of economic operation, is not bettered much beyond 100° F. Furthermore, it is to be admitted that the higher superheat entails more expensive fittings and appurtenances, and is subject to greater repair expense.

Selection of the most efficient vacuum can be similarly in-

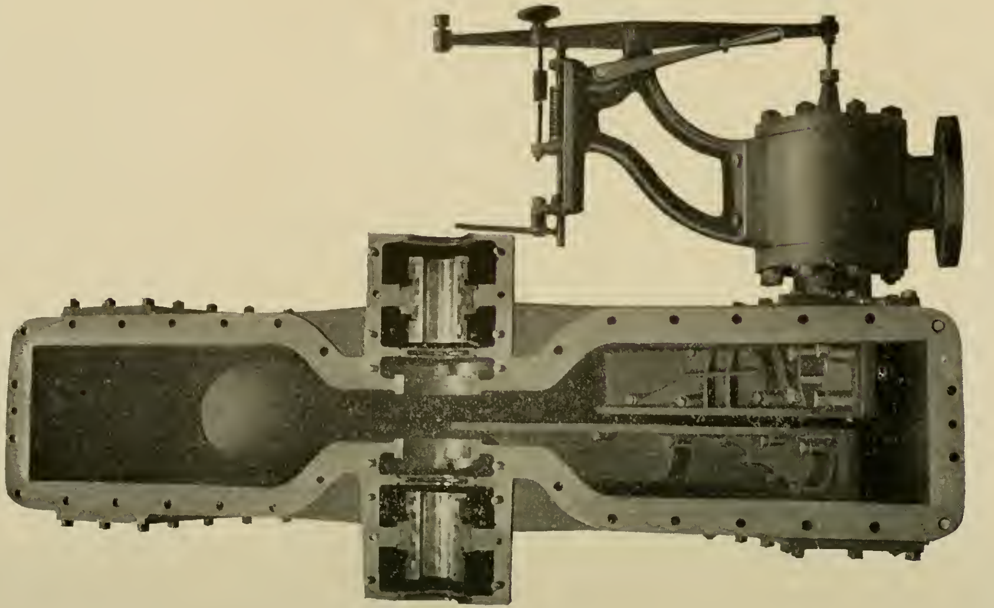


FIG. 6.
Westinghouse Small Turbine, showing nozzle blocks, governor valve and gear.

vestigated. No difficulty is experienced in maintaining 28 inches of vacuum, or slightly above, throughout the year, with efficient condensers of types recently developed, with average water temperatures obtaining at latitudes through the Pittsburg section and above. Ordinarily considered, approximately 28 inches is the normal vacuum to be maintained. Turbines are so greatly benefited by the high vacua that they have wrought a revolution in condenser practice. Referring to the water ratio chart (Fig. 8), giving theoretical quantities of water for steam condensation, the fact is manifest, that the condensing water increases rapidly with the higher vacua. It is, therefore, essential that the condensing system be capable of producing the high vacua with small or negligible terminal difference to reduce the water and power consumption to a minimum.

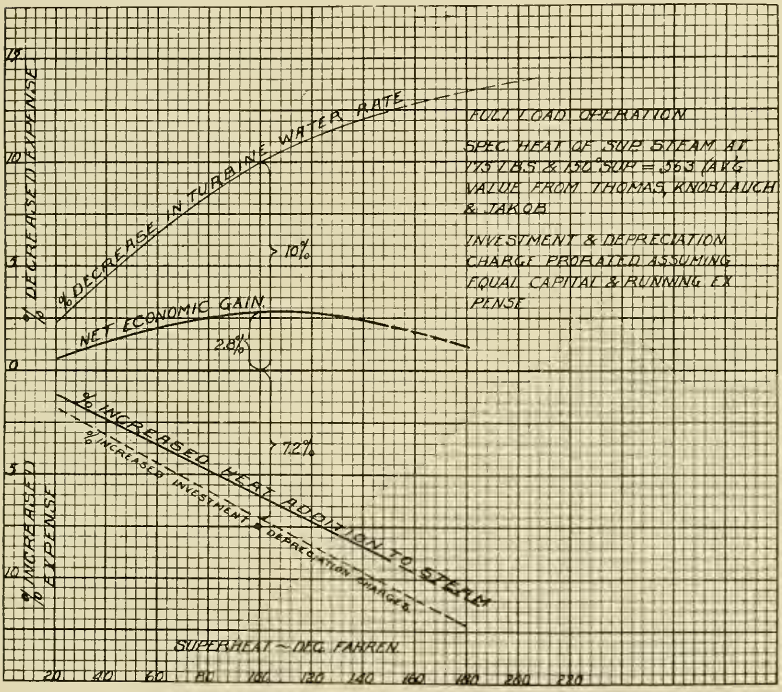


FIG. 7.
True Economy of Superheating.

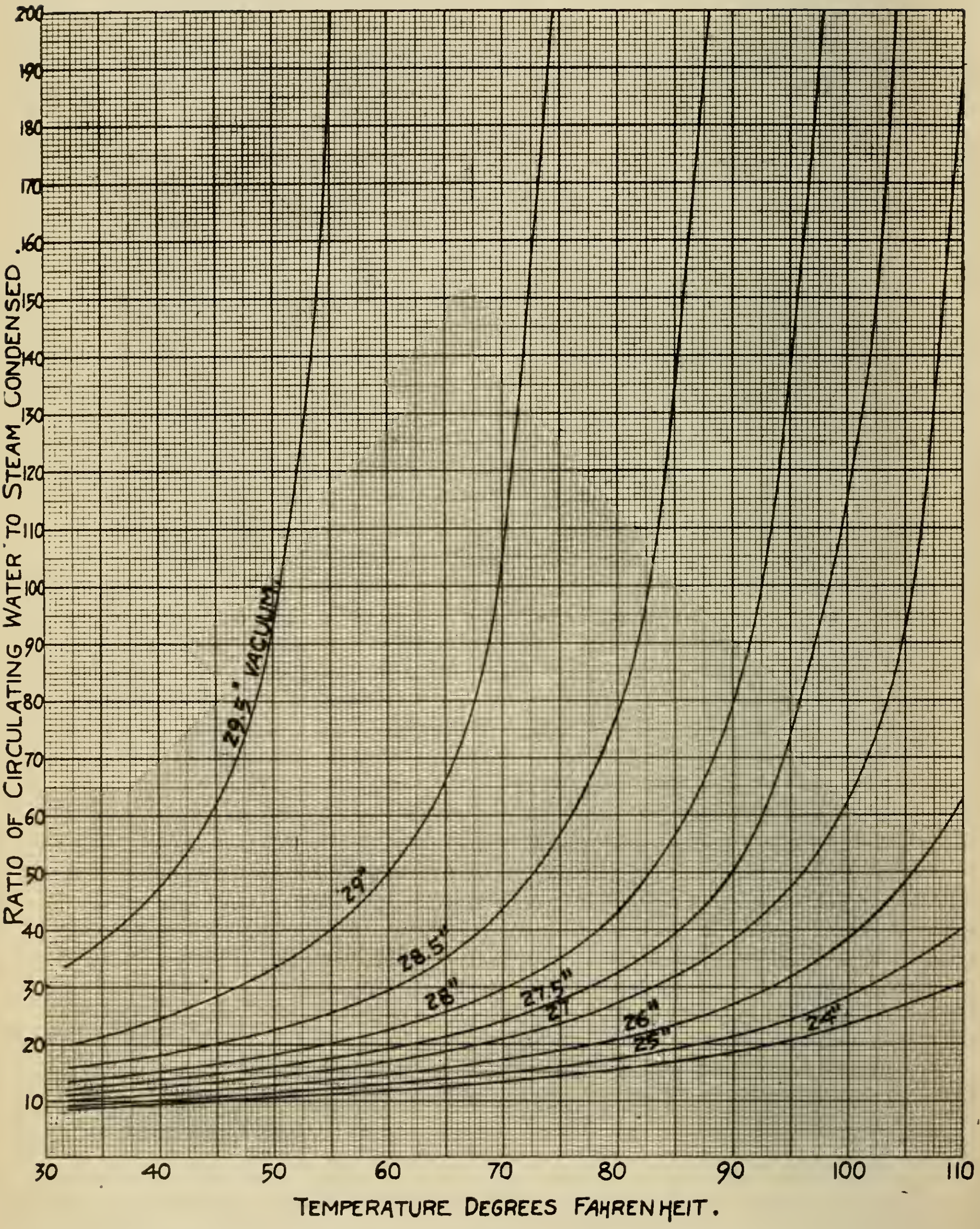


FIG. 8.
Condenser Water Ratio Chart.

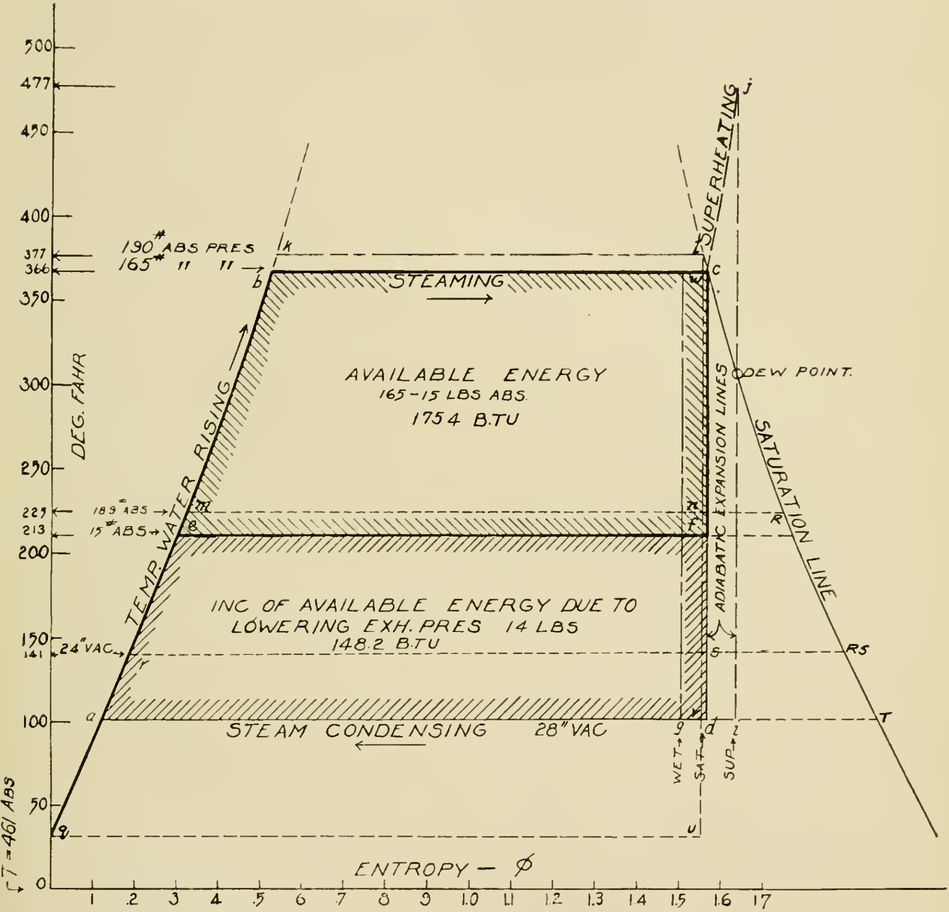


FIG. 9.
Temperate Entropy.

A form of condenser brought cut by M. Leblanc is an exponent of excellent condenser practice. Counter current effect is attained, and harmful effect of clearance in reciprocating pumps eliminated. Other advantages are plainly evident in Fig 9. With this arrangement, the theoretical vacuum may be produced and this is precisely the case of installations in actual service where the conditions of vacuum system are good.

Performance:

What has been said regarding operating conditions becomes more obvious on inspection of the accompanying illustration (Fig. 10). This temperature-entropy diagram can be appreciated without a thorough understanding of thermodynamics. It only need be borne in mind that heat is the product of two factors—absolute temperature and the rate of heat transfer (entropy). Therefore, these factors may be plotted as co-ordinates and areas obtained representing the equivalent energy in B. T. U. Many eminent scientists have contributed to the theory of heat, but this ideal cycle is credited to Rankine and is so termed. Steam engine performances are frequently referred to this cycle as a basis of comparison. Such a reference is generally known as the efficiency ratio or thermodynamic efficiency of the engine. The four operations of the cycle and for simplicity assumed to take place in the engine cylinder, are to be at once appreciated: (a) heat is imparted to water; (b) heat of vaporization supplied; (c) adiamatic expansion occurs (without taking or giving up heat and consequently a vertical line); (d) heat discharged to atmosphere, reciver or condenser.

The theoretical effect of changes in operating conditions can be observed directly. It will be seen that great variations in initial pressure and temperature conditions add or deduct a relatively small amount of available energy. On the other hand, small difference at the exhaust end becomes of great importance. At the same time, when high vacua are considered, the working temperature must be very low.

This diagram also shows very prominently the energy available in steam above and below atmosphere. It has been demonstrated that the turbine in this low pressure range is very efficient and it is now being extensively used as a low pressure or exhaust steam turbine.

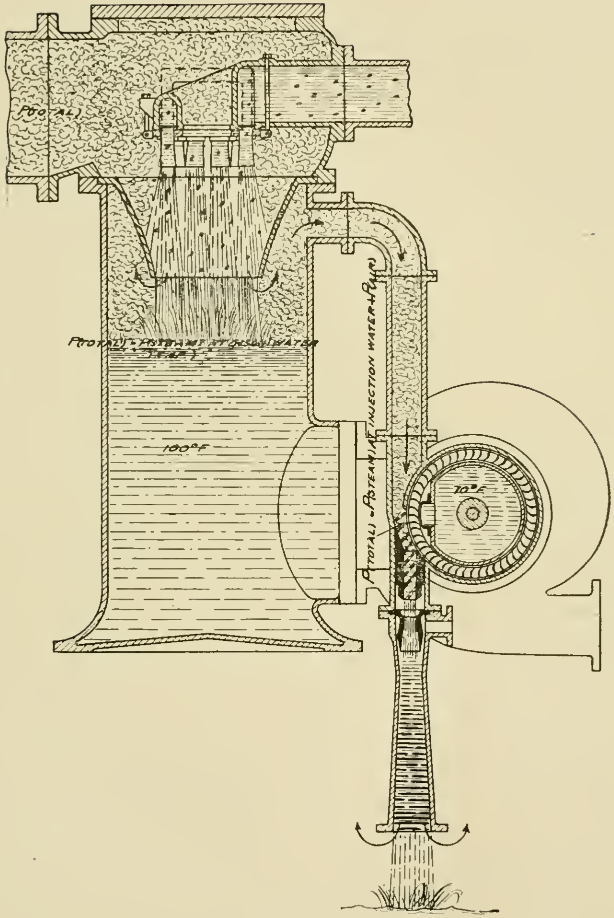

P(TOTAL)
P(TOTAL) = P(STEAM AT [illegible] WATER TEMP.)
100°F
P(TOTAL) = P(STEAM)(AT INJECTION WATER) + P(AIR)
70°F

FIG. 10.
Section Through Leblanc Condenser.

TABLE I.

Steam Consumptions and Efficiencies of Steam Turbines

	Manufacturers. Customer.	Kw.	B. H. P.	R. P. M.	Boiler Pres., Lbs.	Supht. Deg. F.	Vac.	Lbs. Per Kw.	Elec. Effcy. of Gen.	B. H. P. Eff. of Tur.	*Kw. Eff. of Unit	Authority.
	AMERICAN											
REACTION	Westinghouse, N. Y. Edison	9870	13900	750	177	97	27.31	15.00	.95	.70	67.3	Operating Company.
	Westinghouse, City Elec.**	9173	.....	1800	167	59	27.90	14.57	...	...	69.0	J. G. White & Co. Tests.
	Westinghouse, Brooklyn R. T.	11466	.....	750	177	106	28.15	14.45	...	...	65.72	Operating Company.
IMPULSE	Gen. Elec., Chicago Edison	10186	.....	750	176	147	29.47	12.9	...	...	62.1	Consulting Engineers.
	EUROPEAN											
REACTION	C. A. Parsons, Carville	5059.4	7319	1200	194	95	29.27	13.35	.93	.67	62.7	Z. d. V. d. I.*** 1907, p. 1122.
	C. A. Parsons, Chelsea	6000	8500	1000	190	140	28.00	14.08	.95	.69	65.9	Test Results.
	Brown-Boveri, Frankfurt	3521.6	5020	1360	142	130	28.90	13.70	.94	.69	65.8	Z. d. V. d. I. 1908, p. 597.
IMPULSE	Escher Wyss Co., Essen	5118	7345	1025	146	175	27.70	15.1	.953	.67	64.2	Z. d. V. d. I. 1908, p. 1436.
	Escher Wyss Co., Turin	3540	5100	1485	172	90	28.35	15.0	.943	.654	63.2	Z. d. V. d. I. 1908, p. 1437.
	A. E. G., Moabit-Berlin	3169	4720	1500	170	215	29.00	12.7	.94	.68	65.2	Z. d. V. d. I. 1907, p. 386.
	A. E. G., Rummelsburg	4239	6000	1497	173	285	29.00	11.9	.95	.68	66.5	Z. d. V. d. I. 1909, p. 762.
	D. Howden & Co., Manchester	7533	10500	1000	184	133	27.55	14.5	.96	.60	66.4	The Engineer, 1909, p. 462.
	D. Howden & Co., Manchester	6393	9000	1000	188	137	27.40	14.3	.95	.70	67.6	The Engineer, 1909, p. 462.

* Peabody's Steam Tables (1909 Edition) used in calculating Rankine Cycle Efficiency on the kw. hr. basis. Values thus derived average about 1 per cent higher than those obtained by multiplying the b. h. p. efficiency (as quoted from the European reports) by the generator efficiency.

** City Electric Co., San Francisco, Cal.

*** Proceedings of the German Society of Engineers.

The most important feature of this cycle is in determining the theoretical amount of energy available in adiabatic expansion of steam between definite temperature limits, as shown, and on this basis, the best method of gauging and measuring the performance of a steam motor obtains.

Efficiency records of complete expansion turbines that have been formally published in this country or abroad, are presented in table 1. As is evident, low water rates are not necessarily indicative of high efficiency, which, as previously discussed, is secured at the expense of the auxiliary equipment or else does not obtain under average conditions.

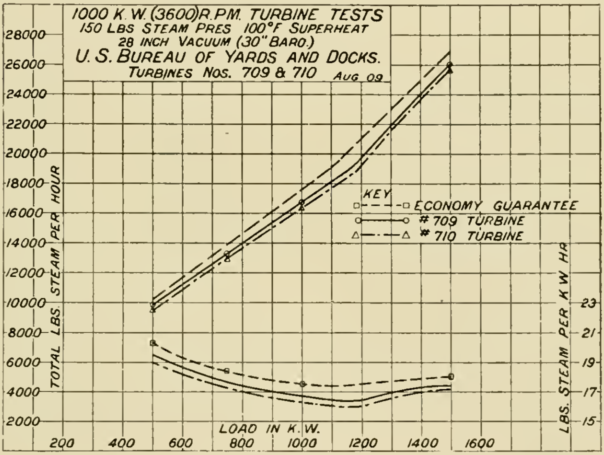


FIG. 11.

1000 kw. Westinghouse Turbine Test, Condensing.

Highly efficient operation has been obtained with the high speed construction shown in Fig. 4, typical of the turbine built for the City Electric Co., San Francisco. The machine operates on 13.88 lbs. per kw. hr. with 175 lbs. steam pressure, 100° superheat and 28″ vacuum, as obtained on official test.

Although with the smaller size turbines, the economy is somewhat less, it is nevertheless much better than reciprocating engine performance.

Official witness tests conducted on a 1000 kw. turbine furnished the government, is shown graphically in Fig. 11.

While the steam turbine has surpassed the reciprocating en-

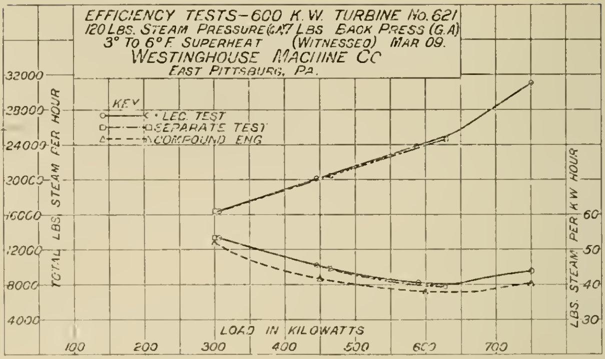


FIG. 12.
600 kw. Westinghouse Turbine Test, Non-Condensing, 7 lbs. back Pressure.

gine in condensing work, this type of turbine, on the other hand, is not at a disadvantage for non-condensing service. On demonstration tests of a 600 kw. turbine under conditions noted (Fig 12), the steam consumption exceeded the performance of a compound engine by an extremely small margin, and when the economic features of the turbine proper are considered, the balance will favor this type of prime mover, even for non-condensing operation.

Low Pressure Turbines:

The low pressure turbine is an attractive means for increased economies in installations where the energy in steam

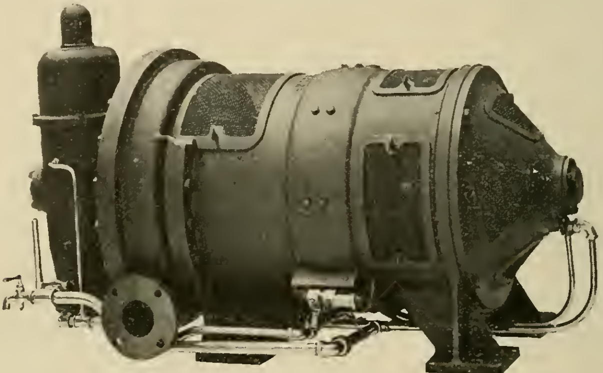


FIG. 13.
25 kw. Westinghouse Train Lighter.

above atmosphere is either wasted or inefficiently used. A typical example of conservation is an industrial plant in the vicinity of Pittsburgh occurs at the McKees Rocks plant of the Pressed Steel Car Co., where two low pressure turbines, one 1000 kw. and one 500 kw. capacity, are installed. They operate on the exhaust from steam hammers, pumps and air compressors, the entire electric power throughout being supplied from this source, except in extremely cold weather, when a part of the exhaust is diverted for heating purposes.

The American Iron & Steel Mfg. Co., Lebanon, Pa., who have a 1000 kw. L. P. turbine, are obtaining a horse power yearly at a total cost of $5.50 for this portion of their power.

Other Applications:

Through the introduction of a practical reduction gear, the large turbine will be used in other fields not hitherto possible on account of inadaptability of speed.

With development in other apparatus, the turbine is used for auxiliary drive—boiler feed pumps, exciter sets, blowers and small generating units.

Of the recent extended use of the turbine, the train lighter and head lighter are most important to the railway engineers.

A view of a 25 kw. train lighter is shown in Fig. 13. It has forced oil lubrication, simple and efficient wheel and good regulation, which are essential features for train service. The head lighter shown in Fig. 13 is totally enclosed and very rugged. It is of ¾ kw. capacity and has a water rate of 185 lbs. per kw. hr., which is good, considering the size and conditions. Excellent governing characteristics has been obtained, the turbine working over extremely wide fluctuation in pressure and load with but small speed variations.

PRESIDENT: If any gentleman wishes to ask any questions on the special features that have been exhibited here, we will give them an opportunity to do so at this time. Mr. Stucki, can we hear from you?

MR. A. STUCKI: I am sorry to say that I cannot add anything. This has been a very interesting paper on a very interesting subject, and we certainly have cause to congratulate ourselves

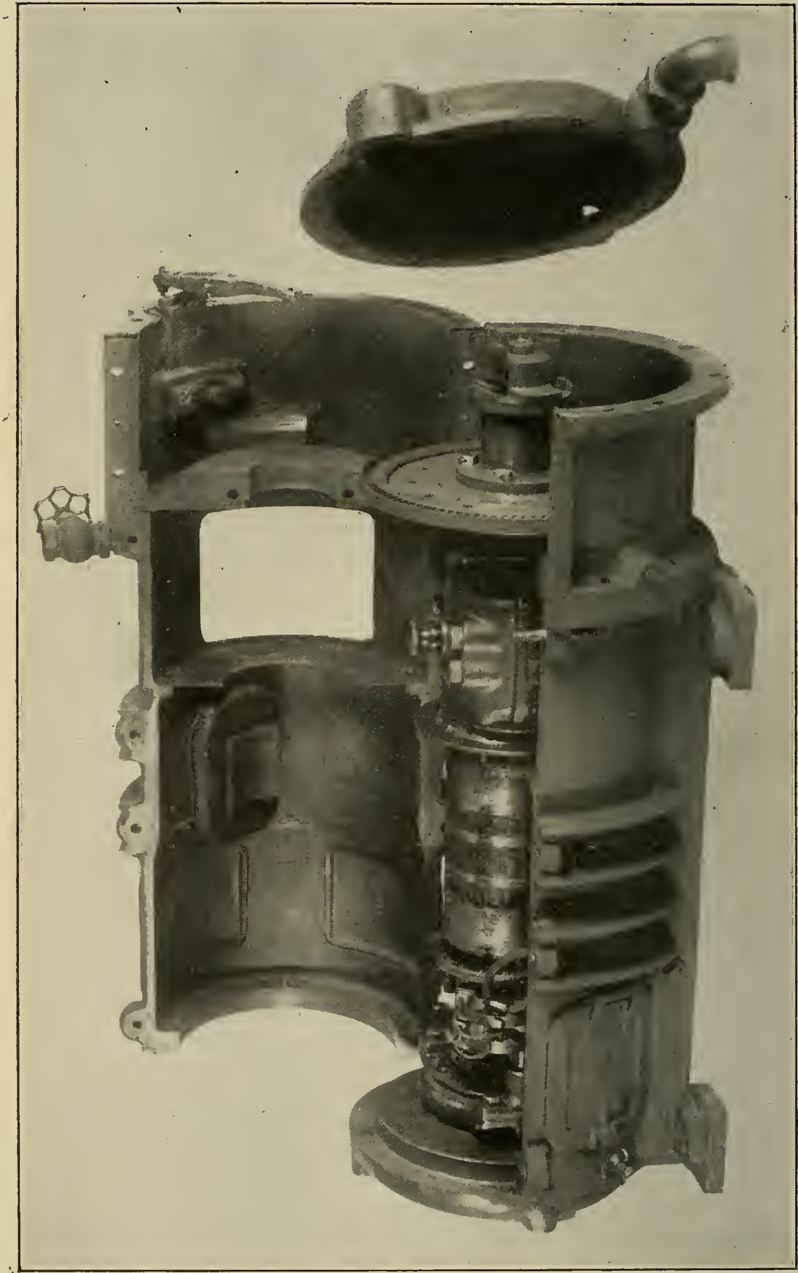


FIG. 14.
Westinghouse Head Lighter.

on having had it presented before us. We all know that the steam turbines have come to the front in recent years in a remarkable way. They have forced their way to the front and they are to-day one of the most important sources of power. We know that generally speaking turbines are very compact as compared with steam engines. The economy in floor space alone is certainly a big item.

Another feature, very important, is its simplicity. There is hardly anything to it, simply a casing and a rotor, and compared for instance with a triple expansion engine, it is a very simple machine. There are no reciprocating parts, hence no shocks, all of which will enable us to get a smoothly running machine. This is turn means that a turbine needs comparatively little attention.

I remember very vividly a 600 kw. machine which I saw in the fall of 1904 at the St. Louis Exposition and which, as the man in charge told me, ran continuously since the opening. This is certainly as good a performance as you can ask for and better than you usually get, especially when you remember that the efficiency is as good, broadly speaking, as in the very best steam engine.

If not out of order, I would like to hear a little more about the comparatives fuel consumption, or rather the relative efficiency between a steam engine, a steam turbine, and a gas engine. Mr. Dreyfus may have some detail figures at hand and if he would be kind enough to tell us, it certainly would be appreciated.

PRESIDENT: Mr. Dreyfus, would you care to express yourself on that point?

MR. DREYFUS: I showed in one case that the turbine has proved itself to possess a higher efficiency than the steam engine. When you come to consider the gas engine, as I said in a slight reference to it, the condition is quite different; this engine equipment costs a great deal more than a similar size steam plant. However, it is more economical in the use of fuel. For example, a gas plant may be considered, roughly speaking, to cost about $130 per kw. The steam plant, depending on the size, costs about $100 per kw. The next question is what are you paying for your fuel? If fuel is cheap, there is no advantage in installing the gas engine, although it has twice the thermal efficiency, or in other words, uses one-half the coal consumption of that of the steam plant. This question involves to a great extent the load factor and running conditions, so that one is unable to cite generalities. Generally speaking, if you have cheap fuel it is a steam plant proposition; if you have expensive fuel, it is a gas plant proposition. At the present time the steam engine, I hardly believe, will be considered in any power plant problem. These remarks are not very definite, but it is a matter in which you cannot give any satisfactory information without having specific conditions at hand.

MR. STUCKI: That is just what I meant.

MR. JEWETT COLE: Will Mr. Dreyfus discuss the comparative merits of the vertical and horizontal type of turbine?

MR. DREYFUS: That is more or less of an embarrassing question, because the vertical types are only built by one manufacturer and it would be best to have a representative of the vertical type turbines answer the query. However, I can say that the builders of this particular type are very rapidly coming to the horizontal machine, which is sufficient evidence in itself.

PRESIDENT: Can we hear from anyone else?

MR. STUCKI: I would like to make a motion that we extend a very hearty vote of thanks to Mr. Dreyfus for his interesting talk.

The motion was carried by unanimous vote.

PRESIDENT: Mr. Dreyfus, you have the thanks of the organization.

MR. DREYFUS: I thank you. I would like to add just one thing. The question was raised by Mr. Redding about visiting the plant of the Westinghouse Machine Co., and I would like to say that the shops are open to be visited by anybody at any time, and whenever it is convenient to arrange for such a trip we will be very glad to see you at the East Pittsburg works.

ON MOTION, Adjourned.

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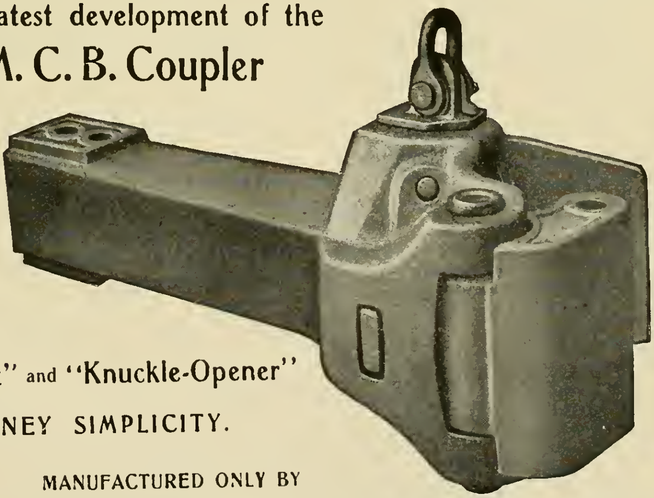

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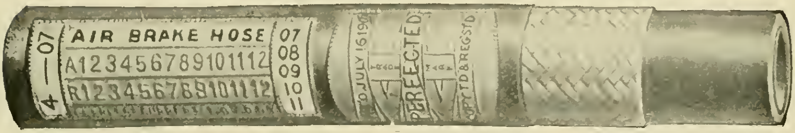

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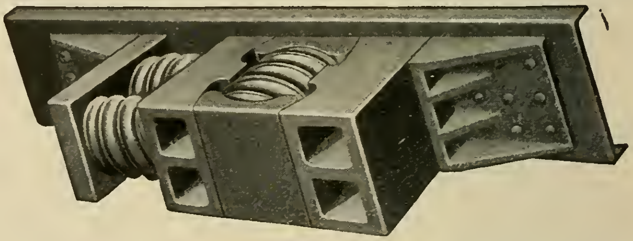

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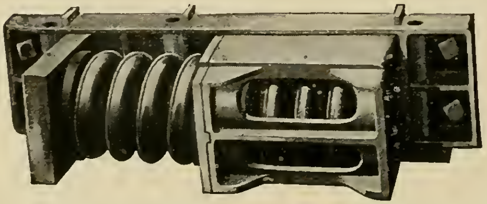

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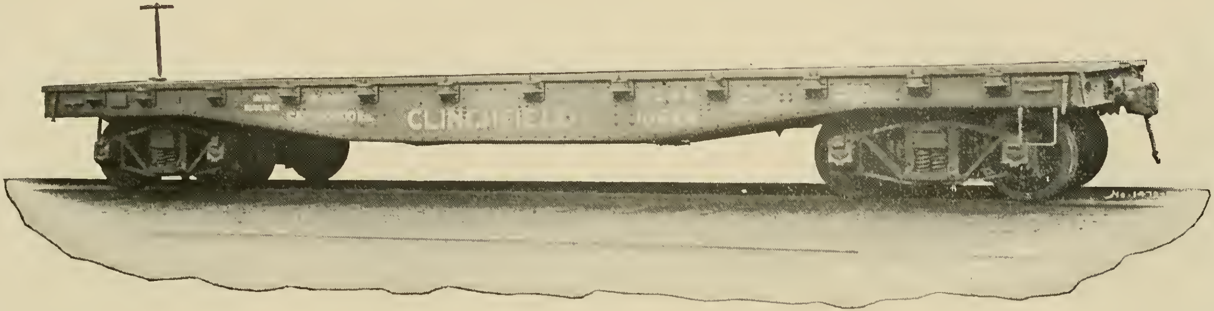

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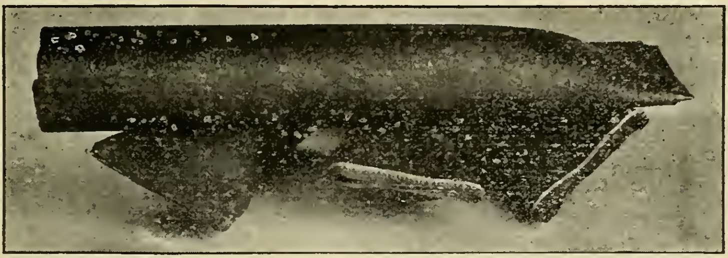

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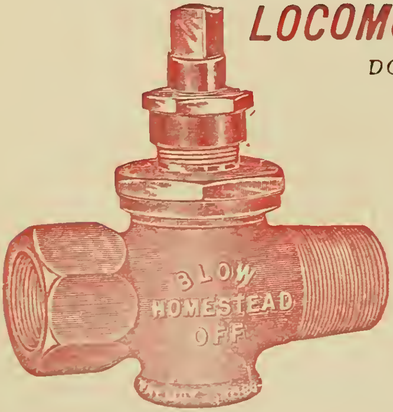

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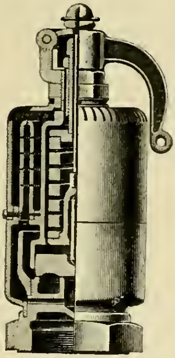

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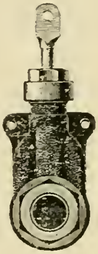

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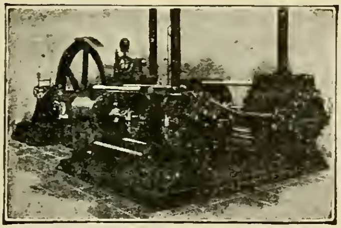

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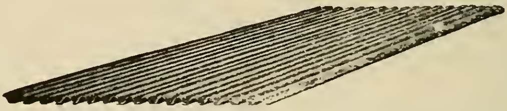

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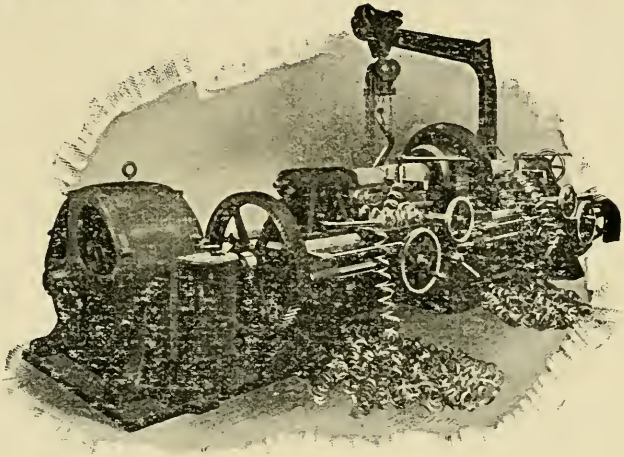

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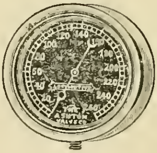

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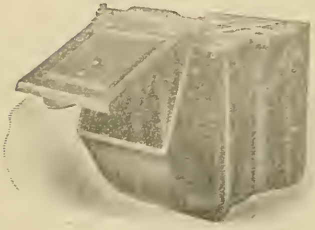

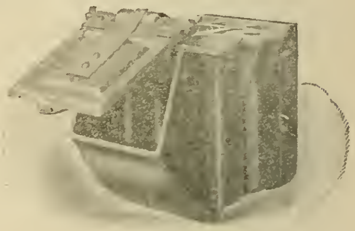

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of the
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ORGANIZED OCTOBER 18, 1901.

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Published monthly, except June, July and August, by the Railway Club of Pittsburgh, C. W. Alleman, Secretary, General Offices P. & L. E. R. R., Pittsburgh, Pa.

Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF MEETING,
SEPTEMBER 17th, 1910.

The practice of making the first meeting after the summer intermission a social meeting, graced by the wives (present and prospective) of the members, is one that has come into high favor.

Its increasing popularity is attested by the fact that the excursion this year was probably the largest, and certainly honored by the attendance of the greatest number and the handsomest-appearing honor guests that it has ever been the distinction of the Railway Club to entertain. The ladies were out in full force, and the men were correspondingly happy.

The outing this year was a trip, under the auspices of the Pittsburgh-Buffalo Company to their extensive operations and model town of Marianna. The party, consisting of eight coach loads, departed from the Union Station at 1:30 P. M., Saturday, September 17th, and arrived at destination after a two hours' run through the picturesque hills of Southwestern Pennsylvania. Weather conditions were perfect, and there was absolutely nothing to mar the pleasure of the day.

Arriving at Marianna, the various features of the town were open for inspection. The mechanical equipment, from the hoist in the large shaft which raises two steel coal cars at a time, each of which holds three times as much as ordinary cars, to the washeries where the coal was given a clean face, exhibited everywhere the most complete and very latest practice. Practically everything is concrete reinforced with steel, and fireproof. And this fireproof feature holds true even down under the ground, for the cross ties on which the rails are secured are steel ties.

But the thing that most persistently assails your eyes and attracts your attention, is the amount of thought and labor and expense that have been put on the welfare department, the sociological side of the town life. The "Hunky" boarding house with its never cool beds, where the night shift crawls in when the day shift crawls out, is absolutely unknown. And even the modern, sanitary two-family house is being rapidly replaced by neat, even elegant, one-family houses of from four to eight rooms, built of brick, finished in the natural wood inside and fitted with gas fuel, electric light, running water and enameled baths. Some of the older coal men are still skeptical as to whether the bath tubs are considered by the miners as anything more than pure ornament, but they may be assured that the miners at Marianna have become "halter broke" when it comes to sanitary uses for water. In fact, the entrance to the mines is through a large four-story house equipped with shower baths and lockers for 1,600 men, and they, too, are found to be of more than aesthetic value.

There is a fine water works system, with fire hydrants on the streets, and a complete sewer system. The houses are on fifty-foot lots and the back yards look as though there had been a prize offered for the best garden, with everybody in the contest.

There was a noticeable absence of empty beer kegs about the place, and the dry railroaders failed to observe a thirst emporium anywhere in the bailiwick. But serious effort has been made to supply adequate forms of amusement to take the place of the saloons. A large and imposing stone-trimmed brick structure which would do honor to any city is the social center of the community. Here are bowling alleys, billiard rooms, a large hall used for roller skating and also for dancing, and a theater fully equipped, with a seating capacity for about three hundred. Then there is a ball park near and the great American game fills a large place in the town activities.

The furnishing of enameled baths, electric lights, shower baths and brick houses to the class of foreigners who dig coal in our mines today is rather a bold experiment, and can hardly be said to be out of the experimental stage yet. But the Pittsburgh-Buffalo Company have frankly acknowledged the responsibility of every employer toward his employes, have recognized the duty of the "brother's keeper," and on this broader upper level are earnestly undertaking this obligation which no law enforced, but Christian sociology alone enforces. And the appearance of the foreigners met on the streets surely indicates that the Marianna experiment has done one of two things—either it has raised the general level of its miners far above the average among foreign miners, or it has succeeded in attracting to Marianna the very cream of the mining population. And in either case, the benefit to the town, the community and the Pittsburgh-Buffalo Company should be cause for sincere congratulation.

Dinner was served in the ball room at 6 o'clock, after which President D. J. Redding called the meeting to order.

PRESIDENT REDDING: We have been enjoying ourselves in a way that might lead you to think that that is all a railroad man has to do. But we do not want to leave you under that erroneous impression. When the trains are running on time and everybody is feeling that things are very smooth in the railroad business and the road is going along nicely, we are nearly always brought back to earth by the presence of the Grievance Committee. The Grievance Committee is a well-established organization among railroaders whose principal duty it is to go to superintendents and other officials and show them that John Smith got two more cars than he ought to have got or than his contract called for, or something of that kind. Now in organizing the Railway Club we carried our organization along the same lines. We have our Grievance Committee. Like the labor organizations, we choose members of the Grievance Committee from among the oldest and handsomest members of the organization. We have followed out that precedent, and I am about to call upon two of the members of our Grievance Committee to tell Mr. John H. Jones and his associates in the Pittsburgh-Buffalo Company of our grievances on this occasion. I will ask Mr. L. H. Turner, of the Pittsburgh & Lake Erie Railroad, to present the first complaint.

MR. L. H. TURNER: On occasions of this sort it is not only proper, but an obligation rests upon us to in some way acknowledge the courtesies offered and accepted. I have tried to discover in what manner the Railway Club of Pittsburgh can make a substantial return to the Pittsburgh-Buffalo Company for the splendid entertainment we have enjoyed and are going to enjoy today, but have failed to find wherein we can be of any use to them, although we can offer them the assurance that if at any time we are able to be of benefit to them, we will be just as prompt in responding to that call as we were in accepting their invitation for today.

The Railway Club of Pittsburgh is a working institution, and we believe we have done some good in the mechanical world, at least, and if our entertainers can absorb some benefit from our work, we will be highly pleased.

Outings of this nature are far-reaching in their effect, particularly to the Club membership. They bring about a greater acquaintanceship and build up stronger friendships, and we are much indebted to those who through their kind hospitality assist so materially in accomplishing this, by bringing the members and their families and friends together.

You undoubtedly have been impressed with the fact that the outing of today is much different in many respects from others which we have enjoyed. We have not only had an opportunity to inspect what is in all probability the best equipped coal mine in the United States, but we have witnessed the rare spectacle of an employer who is endeavoring to promote the happiness and welfare of his employes by providing them with sanitary and commodious homes, equipped with electric light and running water. We also find a bath-house with a capacity of 1,600, which the men may use as they leave the mine on their return from work, and instead of walking through the streets bearing a closer resemblance to the coal they have mined than to human beings, they have an opportunity to change their clothing and return to their homes in a cleanly condition.

Every building in Marianna is owned by the Pittsburgh-Buffalo Company, and we find amusement places, lecture halls and hotels of a much better quality than many older and larger towns in this vicinity can boast of. As compared with other mining towns, we find the wives and children of the miners cleaner and healthier, and apparently much happier, and as I understand it, these magnificent conditions are the result of the moving spirit which governs the Pittsburgh-Buffalo Company, and its head, Mr. John H. Jones.

The Scriptures very truly says: "The laborer is worthy of his hire," but compensation is not always made up of dollars and cents. The effect which the policy of this company will have upon the general welfare and prosperity of the employes will prove more beneficial than the actual wage which they receive for mining coal. There is also a duty which devolves upon the employe. It is not within the scope of every man or woman to be a leader or an educator, but those who are so gifted among the employes and their families, should create and disseminate a sentiment of appreciation, gratitude and loyalty toward their employer. This community of interests that is being built up by Mr. John H. Jones will soon develop into the most deadly enemy to the district organizer, walking delegate, the anarchist and the other sharks whose only object in life is to create trouble in order that they may prey upon the hard-earned savings of their fellow-men to get them out of the trouble which would never have existed had not they themselves created it.

You may have noticed that while Mr. Jones has given the members of the Railway Club of Pittsburgh and their friends every attention, that he has also spent much of his time in seeing that his employes enjoy themselves this afternoon. It is also noticeable and gratifying to see the interest which those whom Mr. Jones has selected to assist in today's entertainment have taken to make this affair as pleasant as possible. In fact, we might almost imagine that it is the employes who are entertaining us instead of the Pittsburgh-Buffalo Coal Co.

I firmly believe that the example set by Mr. Jones will result in the creation of a new order of things, and that its effect will be to illustrate how closely the interests of the employer and the employe are allied, and that when one suffers both must suffer. If the leading spirits among the miners at Marianna place the proper estimate upon the great work that Mr. Jones is doing, strikes, lock-outs, poorly clad and fed women and children, dissipated men, and all the evils which accompany dissension between labor and capital will be strangers to Marianna, and I honestly think that the name of John H. Jones will go down in history as one man who has accomplished much toward bringing the employer and the employe together on the same platform, built on the principles of honesty and integrity, which always results in the greatest good to the greatest number. For all the good things we have enjoyed today and for the object lesson we have been taught, I move you that we extend to the Pittsburgh-Buffalo Company our sincere thanks.

PRESIDENT REDDING: I will ask Mr. Mitchell, of the Pennsylvania Railroad, to further extend our compliments.

MR. A. G. MITCHELL: Having known the members of this firm for over twenty years and in that time having seen them rise from comparatively small beginnings to their present place among the leaders in the business world, through that indomitable will and sturdy honesty of purpose which they all possess, and also having seen that with all their successes they remain the same true gentlemen, thoughtful and considerate of others, as has been exemplified, not only in what has been seen today in our inspection of this great plant, but in their desire to give to the members of our Club, their families and friends an opportunity to see a coal works and village, modern in all its appointments, where the safety, convenience and comfort of the employes were of first consideration, all of which requiring careful and intelligent study, besides giving to us an exceptionally pleasant outing, it, therefore, gives me great pleasure to second the resolution offered.

PRESIDENT REDDING: It having been moved and seconded that we give a vote of thanks to Mr. John H. Jones and the Pittsburgh-Buffalo Company, I suggest that we express our sentiment by a rising vote.

The vote is unanimous.

MR. JOHN H. JONES: Mr. Chairman, Ladies and Gentlemen—I certainly feel very grateful to you all for having accepted our invitation to visit our plant and inspect the efforts we are making to benefit the people who work for us. We are trying to get closer to the men in our employ, trying to make them our friends.

I am not going to burden you with any long speech, because you came here to have a good time. But I want you one and all to know that I appreciate your coming here and that I feel fully repaid for all the efforts we have made to entertain you, by the kind and pleasant way in which you have accepted it. I thank you.

PRESIDENT REDDING: Ladies and Gentlemen—This is our regular session. The business that will be transacted will take but a few minutes and we are going to request that you remain in your seats while the necessary business is being transacted.

We will pass by the regular order of business. I will appoint as a Nominating Committee Messrs. E. M. Grove, J. B. Swann, A. W. Crouch and Julius Krause.

I will ask this Committee to immediately get together and present a list of names of candidates for the various offices to be filled at our next election.

Meanwhile I will ask the Secretary to read the list of applications for membership.

SECRETARY ALLEMAN: I have the following applications for membership:

Ashley, F. B., Purchasing Dept., Pennsylvania Lines West of Pittsburgh, Union Station, Pittsburgh, Pa. Proposed by C. C. Clark.

Booth, Henry, Road Foreman of Engines, D. & H. Co., 5 Canaan Street, Carbondale, Pa. Proposed by J. H. Rosenstock.

Brandt, E. K., Assistant Train Master, Pennsylvania R. R., Union Station, Pittsburgh, Pa. Proposed by J. S. Fleck.

Calvert, H. W., Round House Foreman, P. & L. E. R. R., 516 Marwood Street, McKees Rocks, Pa. Proposed by C. W. Alleman.

Cook, Joseph A., Assistant Train Master, Pennsylvania R. R., 2843 Broadway Avenue, Dormont Borough, Pa. Proposed by H. G. Scheck.

Downes, D. F., Assistant Train Master, Pennsylvania R. R., Pittsburgh Division, 5648 Rural Avenue, Pittsburgh, Pa. Proposed by J. S. Fleck.

Feddersen, H. C., Assistant Train Master, Pennsylvania R. R., Union Station, Pittsburgh, Pa. Proposed by J. S. Fleck.

Huff, C. A., Gang Foreman, Twenty-eighth Street Shops, P. R. R. Co., 5010 Penn Avenue, Pittsburgh, Pa. Proposed by William Elmer.

Jones, E. A., Gang Foreman, Twenty-eighth Street Shops, P. R. R. Co., 7711 Kelly Street, Pittsburgh, Pa. Proposed by William Elmer.

Keptner, J. B., Coal Inspector, P. & L. E. R. R., 1527 Norway Avenue, Beechview, Pittsburgh, Pa. Proposed by C. W. Alleman.

Lockhart, J. C., Representing H. W. Johns-Manville Co., 951

Liberty Avenue, Pittsburgh, Pa. Proposed by C. W. Alleman.

Morse, R. C., Jr., Assistant Yard Master, Pennsylvania R. R., 34 East Pittsburgh Street, Greensburg, Pa. Proposed by J. S. Fleck.

McGraw, Wm. P., Superintendent of Cars, Jamison Coal & Coke Co., Oliver Building, Pittsburgh, Pa. Proposed by J. D. Conway.

Nicol, Geo. A., Representing H. W. Johns-Manville Co., 100 William Street, New York City, N. Y. Proposed by C. W. Alleman.

Pape, Chas. F., Manager, Manufacturing Dept., Hutchins' Car Roofing Co., Hyde Park, Pa. Proposed by J. J. Noland.

Pyle, Philip S., Train Dispatcher, P. R. R., 5539 Ellsworth Avenue, Pittsburgh, Pa. Proposed by J. S. Fleck.

Rafferty, C. D., Assistant Superintendent, Slick Car Wheel Plant, Homestead Steel Works, Munhall, Pa. Proposed by Charles Orchard.

Stewart, S. R. B., Train Dispatcher, P. R. R., 613 Hampton Avenue, Wilkinsburg, Pa. Proposed by J. S. Fleck.

Sullivan, M. W., Road Foreman of Engines, Delaware & Hudson Co., 42 Washington Street, Carbondale, Pa. Proposed by J. H. Rosenstock.

Sullivan, W. H., Assistant Foreman, Twenty-eighth Street Shops, P. R. R. Co., 7315 Idlewild Street., Pittsburgh, Pa. Proposed by William Elmer.

Snyder, Joseph, General Foreman, P. & L. E. R. R., Box 52, Dickerson Run, Pa. Proposed by C. W. Alleman.

Trumbull, A. G., Mechanical Superintendent, Erie R. R. Co., Cleveland, O. Proposed by A. Stucki.

Wiseman, E. B., Division Engineer, Pennsylvania R. R. Co., 3000 Sarah Street, South Side, Pittsburgh, Pa. Proposed by H. G. Scheck.

Wood, Arthur J., Associate Professor, Railway Mechanical Engineering, Pennsylvania State College, State College, Pa. Proposed by C. W. Alleman.

PRESIDENT REDDING: These names will be submitted to the Executive Committee in regular order, and upon their approval the applicants will become members.

The Nominating Committee is now ready to make their report.

MR. E. M. GROVE: Mr. President, your Nominating Committee beg to offer the following names as the nominees for the various offices of this Club for the ensuing year:

President—F. R. McFeatters.

First Vice-President—William Elmer.

Second Vice-President—A. G. Mitchell.

Treasurer—J. D. McIlwain.

Secretary—C. W. Alleman.

Executive Committee (three to elect)—L. H. Turner, F. H. Stark, D. J. Redding.

Finance Committee (three to elect)—D. C. Noble, Stephen C. Mason, C. E. Postlethwaite.

Membership Committee (five to elect)—D. M. Howe, C. A. Lindstrom, A. L. Humphrey, M. A. Malloy, G. P. Sweeley.

PRESIDENT REDDING: What is your pleasure?

ON MOTION, Nominations are closed.

There being no further business,

ON MOTION, the business meeting was adjourned.

SOCIETY OF RAILWAY CLUB SECRETARIES.

Abstract of Minutes of Annual Meeting and Dinner at Atlantic City, June 18, 1910.

The Society of Railway Club Secretaries met in annual session on Saturday, June 18, 1910, at the Marlborough-Blenheim Hotel, Atlantic City, N. J., Mr. B. W. Frauenthal, Chairman, presiding.

At roll call, the responses were as follows:

New York Railroad Club—Daniel M. Brady, Harry D. Vought, Secretary.

Central Railway Club—E. M. Tewkesbury, Second Vice-President; Harry D. Vought, Secretary-Treasurer.

New England Railroad Club—George H. Frazier, Secretary.
St. Louis Railway Club—B. W. Frauenthal, Secretary.

Canadian Railway Club—James Powell, Secretary; P. R. Diamond.

Railway Club of Pittsburgh—C. W. Alleman, Secretary.

Southern & Southwestern Railway Club—F. F. Gaines, President; A. J. Merrill, Secretary.

The Secretary-Treasurer presented the following report, which, on motion of Mr. Frazier, was accepted:

In presenting his annual report your Secretary-Treasurer has no special message to convey at this time that has not heretofore been made history through correspondence addressed to the members. Events of particular interest as affecting the vital welfare of the organization have in this way been brought to your knowledge and understanding, except such as are likely to develop in a specific way at this session. Therefore, your time need not be needlessly engaged with retrospective considerations beyond a mere reference to some that need to be brought into the record for some future occasion when there may be a desire to refer to them in order to settle a dispute or to correct errors with indisputable facts.

In the compilation and publication of the annual index of subjects which so many members of the railway clubs have found of usefulness and corresponding value for reference purposes, the effort has been to do so in time for its distribution either immediately before or soon after the beginning of the season of club work. Unfortunately remissness which amounted to reprehensive neglect upon the part of the secretary of the Iowa Railway Club, and failure also of other officers of the organization to give the slightest heed to letters addressed to them or to telegrams, delayed the completion of the work and explains why the delivery of the booklet was so late. It became necessary to proceed without waiting longer for this club, and so far not one word of any kind has ever been received from its official representatives.

Unavoidable circumstances made it impossible to prepare as soon as expected a tentative plan of organization for the proposed American Association of Railway Secretaries; and, furthermore, it did not seem advisable to undertake to hold a semiannual meeting of the Society for the sole purpose of pursuing this one subject further. The secretaries whom we are desirous of having join with us in this undertaking were all invited to attend this meeting in the hope that the problem could be completely worked out without further delay. While it is gratifying to report that a number of them have received the proposition with favor and expressed their interest as well as a desire to be kept informed as to what progress is made, it is to be regretted that the majority are just at this time attending the annual meetings of the associations they represent. So it will probably be advisable to arrange for another meeting of this Society, preferably in New York, at a time most convenient to all, and the matter can then be carried to a finish.

What was originally presented as a suggestion and experiment it is now the confident belief of its author can be successfully carried out and that a beginning can be made this year along practical lines which will ultimately bring about the object first in view. It is true that many men make many minds, but it is equally true that even a mere exchange of experience and opinion in conference by the 40 or 50 men who are engaged in secretarial work for railroad organizations, should prove helpful, illuminating and, therefore, of practical value and benefit. Whether this declaration shall prove a truism it must be left to time and thoughtful effort to determine, and as it is results that count, it rests with those most concerned to effect the end that is sought.

In the course of the business to be taken up at this meeting there is one matter to engage your attention which, it would seem, has been for some time foreshadowed. Doubtless it might have been averted if fairness and high-minded spirit instead of seemingly unjustified prejudice had not swayed a single mind and unwisely inspired a recommendation that will some day be found to have been a serious mistake. To say that this Society has been of no value, or its work has been without result, and that it has no excuse for living, is an unfortunate disregard of a record of facts which has never been successfully impugned, and, therefore, manifestly unfair. As time makes all things even so will it eventually prove the injustice that has been done.

Respectfully submitted,

(Signed) Harry D. Vought,
Secretary-Treasurer.

In the discussion that followed the Secretary made known that notice of the withdrawal of the Western Railroad Club had been received from the Secretary, Mr. Joseph W. Taylor, which is as follows:

Chicago, June 9th, 1910.

Mr. Harry D. Vought, Secretary-Treasurer, Society of Railway Club Secretaries, New York City:

Dear Sir—I have yours of June 7th regarding annual meeting of the Society of Railway Club Secretaries. At a recent meeting of the Board of Directors the question of continuing membership in the Society was considered and I was instructed to take the necessary steps toward withdrawing. Will you, therefore, consider this as the resignation of the Western Railroad Club from membership in the Society?

Please acknowledge receipt.

Yours truly,

(Signed) Jos. W. Taylor,
Secretary.

It was agreed, on motion of Mr. Powell, to notify the Western Railroad Club that the acceptance of its withdrawal was deferred and that the subject would probably be taken up for some future discussion with the Directors of the Club at some future time.

It was further agreed that a committee consisting of Chairman Frauenthal, George H. Frazier and one other, to be subsequently named by the Chairman, to take charge of this subject.

The Special Committee appointed at the annual meeting of 1909, consisting of H. D. Vought, C. W. Alleman and G. H. Frazier, to report upon the recommendation of the Secretary for the enlargement of the scope of the Association, presented a tentative plan.

The report was accepted and the Committee continued, with the understanding that another meeting would be arranged, the date to be subject to the convenience of the majority of those invited to attend and participate in the completion of the organization of the larger Association proposed.

It was ordered that the report presented by the Committee be printed and sent out to all known secretaries of railroad organizations in line with the recommendations of the Committee.

On motion of Mr. Powell the officers of 1909 were re-elected as follows: Chairman, B. W. Frauenthal; Vice-Chairman, George H. Frazier; Secretary-Treasurer, Harry D. Vought.

There being no further business, the Society adjourned, subject to the call of the Chair.

THE ANNUAL DINNER.

The annual dinner of the Society was held in the evening at the Windsor and had a large attendance. Among those participating, in addition to the secretaries, were:

Daniel M. Brady, Eugene Chamberlain, H. S. Hayward, Jr., C. L. Ferguson, W. F. Jones, George A. Culver and M. E. Davis, of New York; George E. Howard and Charles L. Lum, of St. Louis; C. E. Postlethwaite and John H. Smythe, of Pittsburgh; M. T. Spicer, Richmond, Va.; C. J. Mellin, Schenectady; W. H. Blackmar, Atlanta, Ga.; C. L. Humton and H. C. Hunter, of Parkersburg, Pa.

Covers were laid for forty guests and the occasion was an enjoyable one. Formal speeches were prohibited and song and story ruled the hour.

Mr. Brady, however, in addition to a brief welcome from Mr. Frauenthal, was afforded an opportunity to offer a cordial message he had been asked to present to the Secretaries in behalf of Mr. W. G. Besler, president of the New York Railroad Club, Mr. Besler having gone abroad to attend the Railway Congress.

In this connection Mr. Brady took occasion to quote some extracts from a paper by the late M. N. Forney before the New York Railroad Club, which established a record for railroad clubs as having their beginning cotemporaenously with the M. C. B. and M. M. Associations.

Mr. Chamberlain, it was discovered, had an idea along the same lines and in a few brief remarks confirmed Mr. Brady's statements, saying that it was the New York Railroad Club and its early work, supplemented by that of the Central Railway Club, of which Mr. Chamberlain was President for four consecutive years, that led to the organization of the two associations. The pioneers in this, as early as 1872, were Mr. Forney and the late Leander Garey, who understood the value of organized undertakings, were appreciative of the possibilities to be obtained and demonstrated by results that in co-operation and the interchange of thought many large benefits were to be gained.

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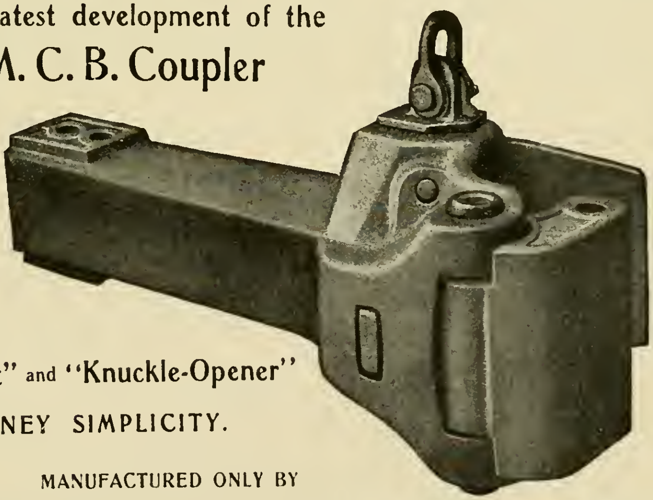

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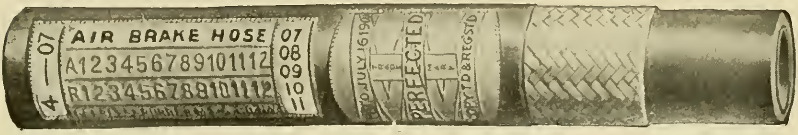

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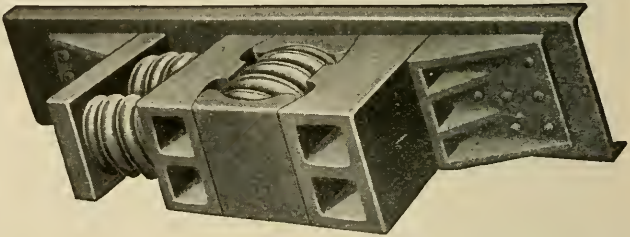

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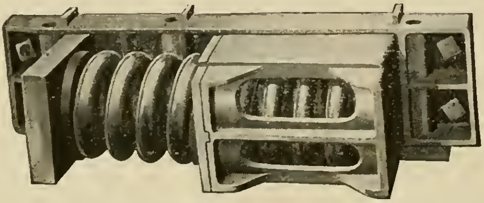

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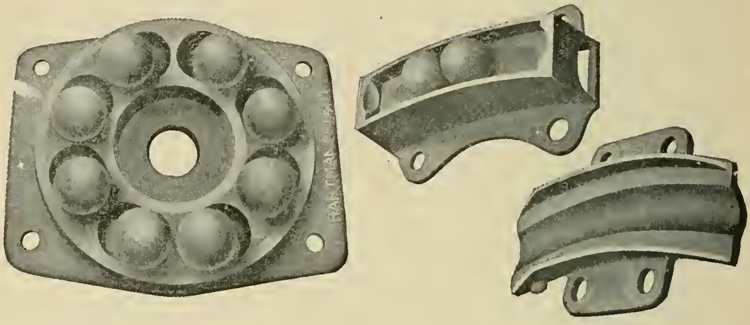

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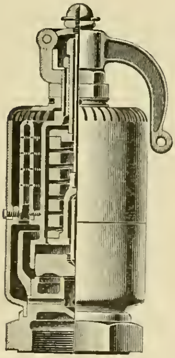

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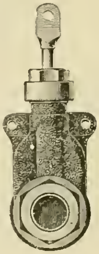

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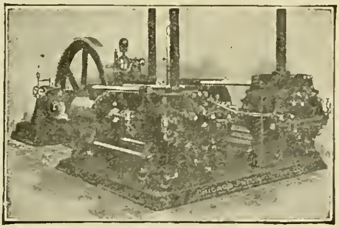

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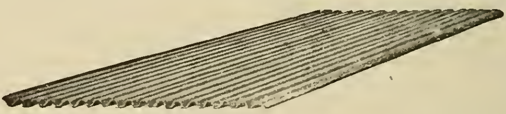

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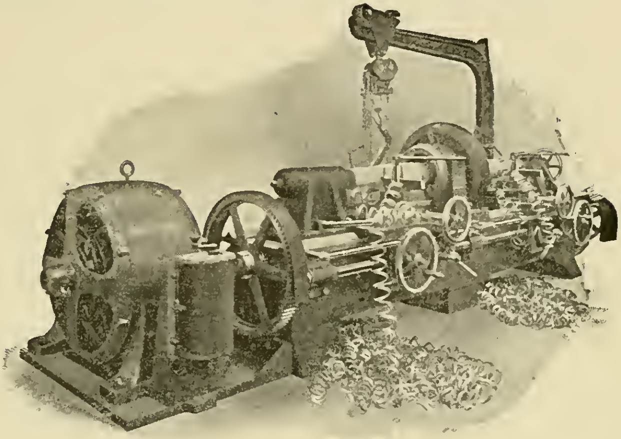

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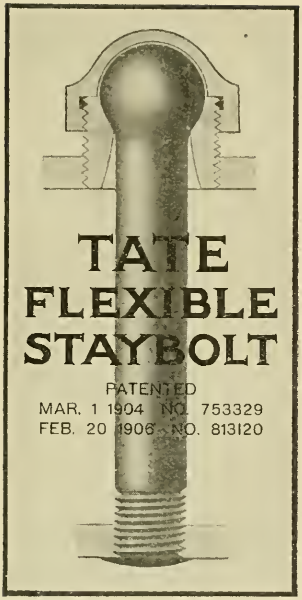

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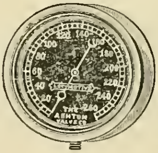

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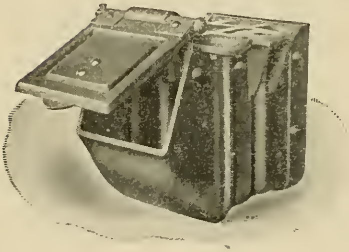

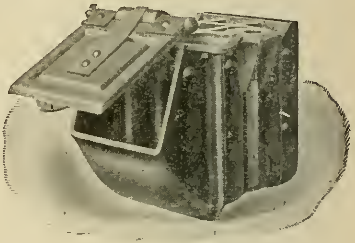

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of the

Railway Club *of* Pittsburgh.

ORGANIZED OCTOBER 18, 1901.

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Meetings held fourth Friday each month, except June, July and August.

PROCEEDINGS OF ANNUAL MEETING,
OCTOBER 28th, 1910.

The meeting was called to order at the Fort Pitt Hotel, Pittsburgh, Pa., at 8 o'clock P. M., with President D. J. Redding in the chair.

The following gentlemen registered:

MEMBERS.

Ackenheil, J. D.
Alexander, J. R.
Alleman, C. W.
Amsbary, D. H.
Anderson, J. B.
Baker, Jas. H.
Baker, J. H.
Barth, John W.
Beatty, A.
Beltz, J. D.
Bennett, R. G.
Black, Frank J.
Brand, Thos.
Brown, L. M.
Bugle, Geo.
Bulkley, B. M.
Campbell, I. K.
Chapin, E. S.
Chilcoat, H. E.
Chittenden, A. D.
Cline, W. A.
Cook, Joseph A.
Courtney, D. C.
Crouch, A. W.
Cunningham, R. I.
Darlington, H. B.
Deckman, E. J.
Drayer, U. S.
Elmer, Wm.
Forsythe, Geo. B.
Fullerton, A. W.
Grewe, H. F.
Griffey, J. W.
Gutierrez, S. J.
Haas, Benjamin
Harner, A. J.
Hauser, W. M.
Howe, D. M.
Hughes, J. E.
Huyett, E. G.
Irwin, O.
Kennedy, Jas.
Kinyon, A. G.
Kinter, D. H.
Kirk, T. S.
Kissinger, C. F.
Knickerbocker, A. C.
Knight, E. A.
Krause, Julius
Kull, W. A.
Lehr, Harry W.
Leonard, James, Jr.
Lewis, A. J.
Lobez, P. L.
Lockhart, J. C.
Long, R. M.
Lynn, Samuel
Mackenzie, R. H.
Malloy, M. A.
Mason, F. N.
Matthews, J. A.
Mercur, H. T.
Millar, Clarence W.
Mitchell, A. G.
Murphy, W. J.
McFeatters, F. R.
McGrory, Percy
McIlwain, J. D.
McNulty, F. M.
McVicar, G. E.
Nicol, Geo. A.
Noble, D. C.
Patterson, C. C.
Pechstein, Albert J. G.
Pfeil, John
Phelps, W. H., Jr.
Porter, H. V.
Publow, John J.
Redding, D. J.
Reese, F. T.
Richardson, C. A.
Robbins, F. S.
Robinson, J. R.
Rupp, R. D.
Ryan, W. F.
Scheck, H. G.
Sitterly, W. H.
Smith, M. A.

Snyder, Jos.
Stark, F. H.
Stewart, S. R. B.
Stucki, A.
Sullivan, W. H.
Sweeley, G. P.
Thomas, J. H.
Trout, W. L.
Tucker, J. L.
Turner, L. H.
Walker, J. W.
Walther, G. C.
Warner, E. O.
Weigel, F. S.
Wescoe, F. B.
Wilson, Henry
Wood, Arthur J.
Wood, Ralph C.
Woodings, Emanuel
Young, W. W.

VISITORS.

Barnhart, B. F.
Bryant, C. W.
Carroll, J. T.
Chrisly, O. B.
Chrysler, W. P.
Conway, Scott M.
Cooper, G. E.
Farrell, Thos.
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Kline, Geo. B.
Leslie, E. E.
Mensch, E. M.
Moran, John
Ostrander, Wm. J.
Ranstine, Frank S.
Root, E. E.
Sargeant, W. A.
Smith, Sion B.
Thurlby, A. R.

The reading of the minutes of the last meeting was dispensed with, they having been printed and in the hands of the members.

The Secretary read the following applications for membership:

Angell, C. P., Assistant Train Master, B. & O. R. R., Pittsburgh Division, 312 Winston St., Pittsburgh, Pa. Proposed by John J. Publow.

Beatty, J. B., Chief Clerk, Car Shops, P. R. R. Co., 816 Sixth Ave., Altoona, Pa. Proposed by J. B. Anderson.

Bell, Walter, Inspector, Penna. R. R., Penna. Lines Bldg., Pittsburgh, Pa. Proposed by M. A. Malloy.

Blakely, T. M., Road Foreman of Engines, Penna. R. R., Penna. Lines Bldg., Pittsburgh, Pa. Proposed by M. A. Malloy.

Brower, R. M., Rep., American Brake Shoe & Foundry Co., 30 Church St., New York, N. Y. Proposed by H. R. Warnock.

Bugle, Geo., Traveling Engineer, Penna. R. R., 346 Miller St., Mt. Oliver, Pittsburgh, Pa. Proposed by M. A. Malloy.

Chrysler, W. P., Assistant Manager, American Locomotive Co., 84 Sevelle Ave., Bellevue, Pa. Proposed by J. R. Robinson.

Clarke, Robert C., Surgeon, P. & L. E. R. R., 129 South Highland Ave., Pittsburgh, Pa. Proposed by Ralph C. Wood.

Cooper, F. E., Manager, R. R. Dept., J. A. & W. Bird Co., 31 Union Square, W., New York City, N. Y. Proposed by D. J. Redding.

Ebens, Howard E., Assistant Foreman, Penna. R. R., Thirty-second and Carson Sts., South Side, Pittsburgh, Pa. Proposed by M. A. Malloy.

Eichenlaub, W. C., Assistant Sales Agent, Union Steel Casting Co., Sixty-first St. and A. V. Ry., Pittsburgh, Pa. Proposed by J. P. Allen.

Farnan, O. E., Assistant Train Master, B. & O. R. R., 4631 Second Ave., Pittsburgh, Pa. Proposed by John J. Publow.

Guy, W. A., Assistant Foreman, Penna. Co., Conway, Pa. Proposed by E. A. Knight.

Hardman, Henry J., Chief Clerk to Master Mechanic, P. R. R. Co., Twenty-eighth St. and Liberty Ave., Pittsburgh, Pa. Proposed by H. W. Rinehart.

Hawkins, M. E., Air Brake Instructor, Penna. R. R., 626 Herron Ave., Pittsburgh, Pa. Proposed by M. A. Malloy.

Hudson, Wm. L., Road Foreman of Engines, Penna. R. R., 212 Union Station, Pittsburgh, Pa. Proposed by M. A. Malloy.

Kinney, M. A., Superintendent Motive Power, Hocking Valley Ry., Columbus, Ohio. Proposed by F. H. Stark.

Lowe, Wilfrid D., Chief Draftsman, Wabash-Pittsburgh Terminal Railway, 7035 Hamilton Ave., Pittsburgh, Pa. Proposed by Ralph C. Wood.

Lybarger, J. H., Reconsignment Clerk, Division Freight Agent's

Office, Penna. R. R. Co., 913 Penn Ave., Wilkinsburg, Pa. Proposed by R. H. Mackenzie.

Mensch, E. M., Assistant Shop Clerk, Penna. Co., Conway, Pa. Proposed by E. A. Knight.

Milliken, John M., Superintendent Car Equipment, Gulf Refining Co., 1773 Frick Annex, Pittsburgh, Pa. Proposed by F. Zinsmaster.

McCauley, Wm., Assistant Road Foreman of Engines, P. R. R., P. O. Box 72, Youngwood, Pa. Proposed by O. C. Coho.

McFarlane, W. E., Assistant Road Foreman of Engines, P. R. R., Elrania, Washington County, Pa. Proposed by M. A. Malloy.

McKenna, Wm. H., McKenna Bros. Brass Co., First Ave and Ross St., Pittsburgh, Pa. Proposed by L. M. Brown.

Nelson, Robert, Rep., Oliver Bros. Purchasing Co., Room 654 Frick Annex, Pittsburgh, Pa. Proposed by J. W. McKeen.

Rabold, W. E., Shop Clerk, Penna. R. R., Twenty-eighth St. and Liberty Ave., Pittsburgh, Pa. Proposed by H. W. Rinehart.

Ransley, F. E., Rep., Greene, Tweed & Co., 226 Lake St., Chicago, Ill. Proposed by J. D. Conway.

Rhine, Geo. B., Engine House Foreman, Penna. R. R., Thirty-second and Carson Sts., South Side, Pittsburg, Pa. Proposed by M. A. Malloy.

Sargent, Luin L., Assistant Road Foreman of Engines, P. R. R., Pittsburgh Division, N. W. Cor. Park and Maple Aves., Greensburg, Pa. Proposed by O. C. Coho.

Schoonover, W. H., Clerk, Penna. R. R., Office General Superintendent, Union Station, Pittsburgh, Pa. Proposed by R. H. Mackenzie.

Stark, Jas. L., General Inspector, Car Dept., Hocking Valley Ry., Spahr Building, Columbus, Ohio. Proposed by F. H. Stark.

White F. L., Mechanical Engineer, Carnegie Steel Co., 1105 Chislett St., Pittsburgh, Pa. Proposed by Ralph C. Wood.

Zimmerman, O. L., Engine House Foreman, Penna. R. R. Co., Pitcairn, Pa. Proposed by C. J. Halliwell.

PRESIDENT: As soon as these names have been approved by the Executive Committee they will become members.

If there is no further business to come up at this time, we will proceed with the paper of the evening, by Mr. A. G. Kinyon, Fuel Expert of the B., R. & P. Ry., entitled "Locomotive Fuel Economy."

LOCOMOTIVE FUEL ECONOMY.

BY MR. A. G. KINYON.

Mr. President and Members of the Railway Club of Pittsburgh:—At a meeting of this club last year a paper was presented which contained statements reflecting very seriously upon the business ability of the management of some of the departments of our railways, and which brought down upon the head of the author vigorous protests from various members of the club, and we believe justly so. While it is by no means our desire to bring ourself into the limelight of any such protest, yet if by doing so we are able to bring home to those in high places the great possibilities of fuel economy in connection with the operation of our locomotives, and thus stir them to action, we shall feel amply repaid even if subjected to severe criticism from some. We hope to not make the mistake the author of the paper did as brought out by the remarks of one of the members in the discussion of the paper, and place our standards so high as to not be taken seriously. We want to be taken seriously, very much so, in fact, and for that reason will endeavor to confine ourself to conservative statements.

The exact figures for the fiscal year ending June 30th, 1910, are not at hand at the time of preparing this paper, but it is safe to say that there has been used on the 57,000 locomotives in this country in that time not less than 150,000,000 tons of coal at an average price of $2.25 per ton delivered on the engine, bringing the cost for fuel up to the appalling sum of $337,000,000 for the year to move the traffic on our railroads.

We feel that we are not over-estimating the possibilities in any particular in saying that this amount can be reduced 20%. Not, however, without some expense which would bring the net saving to about 15% or $50,000,000 a year.

Any railway management that can figure by reducing grades and eliminating curves to increase their train haul to pay 6% on the investment, will not hesitate to do so if they can secure the money to make the betterments.

In the matter of fuel economy we have a chance to save several times 6% and with only comparatively light expense, and one of the purposes of this paper will be to show that this is a conservative proposition.

That the men on the firing line appreciate the immensity of the possibilities is shown by the organization, some two years ago, of the International Railway Fuel Association, which has as its object the improvement of its members in an educational way and the advancement of its employers' interests by recommending the adoption of best methods for the promotion of fuel economy. This association, not yet two years old, had a membership of 277 on May 31st, 1910, and is bound to be an important factor in bringing out the possibilities in this field.

As a basis of comparison of results possible, let us take the matter of oils used for locomotive lubrication and illumination. Time was when the fireman went to the oil house and filled his supply cans, and if they were so filled that a trail of oil was left on the ground (as was often the case) from the oil house to the engine, nothing was thought of it other than the mess it made. In filling engine oilers or lubricators, after they came into use, they were known to be full only as they run over. In oiling around more oil would be spilled around the oil holes than would be put in them and we have seen men move from one driving box to the next one without righting the can, and this before we had the can with the valve in the spout.

Now, all this is changed and we are lubricating and lighting our locomotives at less than half the cost of those times, and in our present better practice look back and wonder how such careless methods prevailed as long as they did. Not only by more careful use of the oil have these betterments obtained, but by improved lubricating devices, better designed and fitted bearings, and last, but not least, more careful instruction and supervision in the use of the oil. This instruction and supervision has been and is today carried on by the oil company which is supplying most of the railroads in the country, and surely if it is a profitable thing for them to reduce the consumption and increase the efficiency of their goods, how much more so must it be for the railroads who have to pay for the goods? And how immeasureably must this be true in regard to fuel, can only be appreciated when we understand that the cost for oil on our locomotives is less than 3% of the cost for fuel, so that it is reasonable to assume that with the same care and effort put forth in the use of fuel we could save 35 cents where we are saving one cent on oil, and we are not sure that the saving of one cent in the cost of oil is not sometimes made at an expense of several cents for coal as well as material and labor. Tests made several years ago on a western road demonstrated that the efficiency of the locomotive was reduced nearly 50% when the valves and cylinders were allowed to become dry.

We would group the lines along which improvements can be made in what appears to us to be their logical order.

SUPPLY COAL.

The matter of supply coal must of necessity be regulated by local conditions. If the haulage is long, the best coal procurable should be purchased, as the cost of haulage is the same for all grades. In cases where the coal is mined along the line of road, it is often possible by proper arrangement of draft appliances to burn a grade of coal successfully that could not be disposed of to an advantage to other consumers and thus reduce the cost of the fuel as well as foster line of road industries.

As far as possible the same grade of coal should be supplied to a district. As the men become familiar with its characteristics they will handle it to the best advantage, and if the service is such that the power can be kept in the same district, the draft appliances can be adjusted to burn this grade of coal to the best advantage, all of which would be changed if a different grade of coal were used or the power changed.

The coal should be handled as little as possible to avoid pulverizing it, for while the actual heat value of the coal is not impaired by being fine, its heating possibilities are reduced by the difficulty of handling the fine coal in the fire box. With the very fine coal it is more difficult to keep an even-burning fire and much of the fine coal will be drawn directly into the flues, becoming not only a loss but plugging the flues as well.

Run-of-mine coal should have the large lumps broken to a size not exceeding two-inch cubes. This also applies to screened coal. If the fireman is compelled to spend much of his time in breaking coal, he can not give his fire the attention it must have for best results. Coal made up of large lumps and slack is a bad combination, as it is very difficult to keep a solid fire with it.

The storage of coal is a fruitful source of loss, particularly when stored in the open as much of it is. The deterioration by the evolution of the volatile matter is a serious loss and also causes the coal to pulverize or slack, but this is a condition that is unavoidable as it is often necessary to store large quantities of coal to guard against strikes, blockades, etc.

The practice of dumping coal on the bare ground should not be permitted, for when it is gathered up with a steam shovel or clam-shell, as it usually is, a great deal of mother earth is gathered up as well, which causes a dirty and inefficient fire. A cement storage yard will pay for itself in a short time for this reason.

Too little care is given to coaling engines. In handling oil we have storage tanks to prevent leaks and evaporation, and expensive self-measuring and registering devices which accurately measure and record all oil received and issued and a system of tickets and accounting gives us accurate knowledge of just what results are being had.

But with our coal it is far different, and the indifference on the part of those to whom it should be of the most interest to have these wastes stopped, causes a greater indifference on the part of those in the ranks. Many coaling stations have no way of measuring or weighing coal delivered, the amount put on an engine being left to the guessing ability of the man in charge of the station, his guessing ability varying with the necessity of having his coal received, as indicated by the car bill weight, balance with his coal delivered. Tenders are heaped up in many cases, so coal is lost off along the road, which is not only a loss but a menace to the men working along the track.

Coaling station devices are manufactured that will not only accurately weigh the coal but print a ticket showing the exact amount delivered to an engine and will, from their control, allow the tanks to be filled without over-filling.

PERFORMANCE SHEETS.

Fuel performance sheets should be compiled and posted each month, and the data should be as accurate as possible to have its full value, even if the cost for compilation amounts to considerable.

This sheet to be most effective should show the individual record of each engineer and fireman, as well as engine, the calculations should be made as far as possible on the 100-ton mile per hour basis, but the ton mile or car mile basis is better than no performance sheet at all.

If we can place before a man, either engineer or fireman, a statement showing in a fair way that he is not doing as well as the other fellow in the same service and under like conditions, we have something with which to work and can insist upon an improvement if his natural pride does not prompt him to better efforts.

CONDITION OF LOCOMOTIVES.

The condition of the locomotive has much to do with fuel economy, and it is the poorest possible policy to neglect repairs that might cost only a few dollars and by so doing consume a hundred dollars' worth or more of extra coal a month. We cannot, nor should not, expect 100% efficiency on the part of the men unless we give them 100% conditions. And yet we know of mechanical department men who are so intent on making an economical showing or record on running repairs that this is done, they forgetting that it is all one company and that it is only a very small man who will strive to build up an individual record at the expense of the company for whom he is working.

Poor steaming engines are far more wasteful of coal than excessively free steamers. And in an effort to get steam out of a poor steaming engine, the fireman is apt to get into very improper methods which he will be apt to continue on a free steamer with very wasteful results.

It is not our purpose to advocate any particular kind of a front end arrangement in this paper, though we have some very decided ideas on the subject. In all cases the steam and exhaust stand joints, as well as the exhaust tip joint, must be tight. Many poor steaming engines are so from these defects, and a failure to find such leaks, due to improper methods of testing in the shop or round-house, accounts many times for the continuance in service of an engine that not only tries the patience and endurance of the crew to get over the road, but burns many tons more coal than is needed.

These joints should be subjected to a water test at boiler pressure. To do this a plate should be placed over the nozzles with a suitable gasket, held down by some means other than a block and jack from the top of the smoke arch. This plate should have a small cock in it to let the air out when the water is introduced, and a gauge should also be placed in this plate to show the pressure in the test; as the pressure in the test gets there only by leaking by cylinder and valve packing, and we could not be sure that the pressure was had otherwise.

While it is true that we never get boiler pressure in the exhaust pipe while working steam, if the joints are tight with boiler pressure, they surely will be tight under working conditions. This test should be made to determine leaks, and be made again after pipes have been ground in, or after removal for any cause.

Careful tests should be made to know that exhaust pipes, nozzles and stack are in line and plumb with one another, and when the petticoat pipe is used great care should be taken to have it plumb and central with the stack and at such distance from the base of the stack to insure the exhaust steam filling the stack shortly after entering the base, and should be firmly secured so it cannot get out of place.

We think the petticoat pipe is an unnecessary adjunct to the front end as well as a dangerous one, and measures should be taken to dispense with its use on all engines. The height of the draft sheet is an important factor in the steaming qualities of a locomotive, and any change in its position should be made only on the recommendation of some one who is competent to fire the engine and know that an uneven burning of the fire is not due to some pecularity in the method of firing, restricted openings in the ash-pan or grates, or some other cause rather than the position of the draft plate.

The size of the nozzle is of great importance and should be as large as possible and have the engine steam well, but no larger. A nozzle enlarged to a point where the engine will not steam is nearly as hard on coal as one with the nozzle too small. We are satisfied that the practice of reducing nozzles to make an engine steam is resorted to altogether too often, with a resulting greater coal consumption and decreased efficiency. The reduction of the nozzle should be the last thing resorted to in an effort to make an engine steam. All other parts that effect the steaming qualities should be examined and known to be right before a change in the nozzle is made. A reduction of one-fourth inch in the size of the nozzle can easily increase the coal consumption a ton or two per hundred miles, while if the real cause of the steam failure was located, it might be possible to increase the size of the nozzle. In an effort to burn fine or slack coal, nozzles are reduced so much that holes are torn in the fire, requiring that a much heavier fire be carried and raking resorted to frequently, which is hard on the coal pile, firebox sheets and the fireman.

All possible chances for air leaks into the front-end, as well as steam leaks, should be guarded against, as air coming in at such places not only tends to heat and warp the adjacent parts, but prevents a corresponding amount of air coming in through the fire, retards combustion and causes clinker, if there is any clinker-forming material in the coal.

The flues should be kept clean, not only to preserve all the heating surface, but to insure an even-burning fire. The blowing out of hot flues with cold compressed air is poor practice on account of chilling effect, and should not be done where it is possible to use steam for this purpose.

Valves and cylinder packing, as well as valve stem and piston rod packing, should be tight, as any of these or other steam leaks are not only a loss but impair the efficiency of the locomotive.

The condition of the interior of the boiler as to scale is an important factor and should not be lost sight of. Aside from the scale-forming tendency of boilers run too long between boiler washings, trouble will be had from foaming, which will cause dry valves and cylinders, requiring that the locomotive be worked harder to handle trains, consuming far more coal. Dirty water will not so readily generate steam, so where trouble is caused by foaming or scale-formation, it is advisable as well as economical to use a boiler compound, but care should be taken in the selection of such compound and know that it is adapted to the particular water with which it is used.

The value of the brick arch in the matter of fuel economy is entirely overlooked by some railroads. We believe that too much cannot be said in its favor. It is not only a fuel saver and smoke preventative, but is a great protection to the flues and fire-box sheets when properly designed and applied, and will more than pay for its installation and maintenance.

The brick arch has been developed in the past few years so that the old objections as to first cost, maintenance, and danger from arch tubes becoming mud burned and bursting, have been eliminated. The large heavy bricks of a few years ago have been displaced by much smaller sections, and these sections so designed and placed in position on the arch tubes that they can be removed without difficulty or danger of breakage, thus permitting repairs to be made to flues and the renewal of burned out or broken bricks, without destroying the whole arch, as was formerly the case. By using the revolving disk cleaner to keep the arch tubes clear of mud, the danger from arch tubes bursting is entirely overcome. The efficiency of the brick arch as a fuel-saving device and smoke preventative has been increased by having the under surface of the brick corrugated, which further delays the escape of the gases of the coal from the fire-box, compelling them to mix more intimately with the oxygen of the air, and this, together with the uniform high temperature of the arch, causes more perfect combustion of the gases and smoke formation, and the losses incident thereto prevented.

The importance of closing the fire-box door after each shovelful of coal is great and to give the fireman no excuse for not doing so, it should be kept in good order so it can be opened and closed easily. If a swinging door, the latch should be adjusted to hold the door open positively while putting in coal, as it is very annoying to have a door swing shut as coal is being put in. The door should not swing open too far, as this involves extra labor in swinging, and a chain should be provided where practical, hung from the ceiling of the cab and only slack enough allowed to let the latch drop into place. If a sliding door, the levers should not be allowed to become worn until they work hard and bind.

The pneumatic fire door is a factor in fuel economy as well as a help to the maintenance of fire-box sheets and flues and for these reasons will pay for itself in a short time.

A large amount of coal is lost by faulty grate construction or conditions, especially where fine coal is used. Grate fingers broken or burned off allow much coal to fall through them into the ash-pan, which is not only a loss, but, catching fire, warps and burns the pan. Grates should be put up so they can be shaken easily and fastened in their level position securely. When a detachable shaker bar is used it should be fitted to the shank so there will be no danger of its slipping off when in use and injuring the fireman. The height of the shovel sheet and deck should be the same and the shovel sheet free from holes or projections.

The deck sheet should be fitted carefully about the shaker shank and no holes left in it so that coal falling on the deck will drop through and be lost.

A number of mechanical stokers are being tried out at the present time, and while none of them, to the writer's knowledge, have thus far proven equal to intelligent hand-firing in continuous service, we believe from the fact that some of them frequently make successful trips, that they will be perfected to a point in the near future where they will be installed in large numbers. In fact, we have recently learned of one in use that is making a remarkable record for efficiency and stability and promises to solve the problem. We refer to the Hanna stoker on the Queen and Crescent.

For the average fireman a light-weight No. 3 scoop should be provided, with a comparatively straight handle. While the use of the rake as a firing tool is to be discouraged as much as possible, there are times with fine coal, especially, if it be of a coking nature, when it can be used to an advantage. The coal pick should be of medium weight and have a large deep eye and good handle.

The ash pan, its construction and attachment to the locomotive, should be carefully considered, as the steaming qualities may be greatly impaired by restricted openings in the pan. Not only should these openings be ample in size, but should be so constructed as to insure the air admitted going up into the fire and not rushing through and out at the rear of the pan, and thus require a reduction of the nozzles to create vacuum enough to induce a current of air through the fire, which might be the case and often is, especially at high rates of speed.

Mr. LeGrand Parish, when Superintendent of Motive Power of the Lake Shore, made some very exhaustive experiments along this line, which resulted in the designing of an ash-pan for use on their fast passenger locomotives, which produced remarkable results in fuel saving and increased efficiency by permitting the use of a larger nozzle.

The location of the steam gauge should be given consideration. As the locomotive boiler has increased in size the steam gauge has been elevated until in some cases it is necessary for the fireman to stand on the seat box to see the pointer. On the large engines the steam gauge should be placed below the throttle-stem or to one side, if in the way there, but at a height not to exceed five feet from the deck. Close firing require close observation of the pressure, and we cannot expect this if we place the gauge in its present inconvenient position.

THE USE OF THE FUEL.

We now come to the most important part of the subject, the use of the fuel, and we trust you will be patient with us if we go into this at considerable length because we believe that this has the least consideration given it of any part of the subject of fuel economy.

We call to mind several articles and papers presented to the various railway clubs and associations, in which the purchase, inspection and accounting of coal has been very ably treated, and as a result much progress has been made along these lines; but stopping at this point, we have much the same condition as when the cow kicked over the fine mess of milk.

KINDLING FIRES.

In kindling fires the best accepted method seems to be to cover the grates after they have been cleaned of all accumulation of clinkers in the air spaces, with a layer of well-broken coal evenly distributed over the grates to a depth of about four inches. Over this should be spread a layer of coarse saw-dust or shavings thoroughly saturated with fuel oil, and this ignited by throwing upon it a piece of oil-saturated lighted waste. It should be the aim to allow time enough for this coal to become thoroughly ignited before the fire is disturbed or more coal added. Often in an effort to hurry a fire it is raked or puddled and more coal added, which does not hasten matters at all, but serves to cause clinkers and thus handicap economical and efficient results from the start.

KEEPING UP THE FIRE AT TERMINALS.

In keeping up the fire at terminals a point to be considered is not to get it so hot that the pops will lift and blow away water, but to keep the steam at such pressure as to allow of getting the engine hot on short notice. To do this the fire should be banked at the flue sheet rather than at the door. The banking at the flue sheet prevents cold currents of air coming up next to it and chilling it, thus preventing leaks and maintaining a more constant steam pressure with much less coal than would be the case if the bank were made next to the door. Any air coming in at the rear of the box will be prevented from striking the flues by the hot air arising from the bank and will do no harm, and it will be found that a fire banked in this way will last much longer without attention, will not cause the engine to pop, and when broken out will allow the engine to be gotten ready for service on short notice. In cold weather, if the engine is to stand with heaters on, it will be necessary to refill the boiler with water occasionally. The fire should be stirred out for this purpose, but banked again next to the flue sheet, pushing some of the bright fire forward before banking to prevent popping. When an engine is ordered the fire should be broken out and steam gotten up to about 50 pounds of boiler pressure, and the boiler filled fairly full of water; then the fire should be covered with a layer of coal sufficient to deaden it and coke over without raising the temperature, so as to raise the pops. If care is taken in this matter an engine can stand for an hour or more with a stationary steam pressure, and a condition of fire had that requires only to be stirred out or broken up shortly before leaving time, to have a full head of steam and a bright, hot, clean fire to start with.

HOSTLING ENGINES.

In handling the engines to the round house, or to and from the coal chute or ash pit, the hostler should not fill the boiler so full as to work water over the valves or through the cylinders, washing off the lubrication and dirtying the engine. In moving engines under their own steam after fire has been dumped, the movement should be as short as possible, as the cold air drawn in will be very harmful to the flues and fire box sheets. If a little time is spent in warming up the cylinders of an engine that has been standing for some time, by opening the cylinder cocks and throttle slightly and reversing the engine several times, and then moving over to the next quarter and repeating the operation, much of the throwing of water will be prevented. Care should also be taken to start the air pump slowly with the drain cocks open, as the water from either of these sources not only dirties up the engine, but some of it falling back into the front end, moistens and clogs the netting and seriously impairs the steaming qualities. The proper condition of the fire when delivered to the crew has been outlined in a previous paragraph.

CONDITION OF FIRE AT COMPLETION OF TRIP AND CLEANING FIRES.

A considerable saving of coal can be made in cleaning fires, if the fire is in proper condition when engine comes onto pit. This requires the co-operation of the crew bringing the engine in, the hostlers and the engine watchmen. As a rule, some time elapses between the time the crew gives up the engine and the cleaning of fire. At the completion of trip if the engine has been properly handled and fired, the fire should be even in thickness over the grates, the boiler full of water and the steam pressure 20 or 30 pounds below the maximum. Before leaving the engine on arriving track, if it is not to be turned over to the hostler direct, the crew should bank the fire next to the flue sheet, and so arrange as to steam pressure and water level that the pops will not lift or the water level drop materially, until the hostler or engine watchman shall take charge. The hostler or engine watchman should plan in keeping the fire up to the time of delivery on the ash pit, to build it up quite heavy at the flue sheet, have the boiler full of water and the pressure such that there will be no chance of the pops opening while on the pit, and still have steam enough for movement to round-house or storage track after fire is cleaned. When placed on pit, any unburned coal or live fire on the back section should be pushed forward by a hoe or scraper made for that purpose. When dump grates are provided, front and back, as they should be, the back section should be shaken after the live fire has been pushed forward, to break up the clinkers and shake the ashes through as much as possible, then the dump dropped and the clinkers broken up with a bar and forced through. Grates should then be put in position and the good fire pulled back onto cleaned section and covered over with a layer of fresh coal to deaden the heat, while the front section is being cleaned in the same manner. The front section should then be put in place, the good fire pushed forward and coaled over, being careful to leave no holes or thin places near to the sheet. The excessive use of the blower while cleaning fires should be carefully guarded against; it should be opened only wide enough to prevent the gas and smoke coming out the door. The manner of handling the fire when the engine is stored has already been explained.

INSTRUCTION.

Instruction is the key-note to fuel economy, but to be effective, it must be followed by supervision and demonstration. Instruction by means of books on fuel economy is good, instruction by correspondence courses is also good, and instruction by lectures direct to the men is best, but if any or all of these, made up of proper information, are supplemented by practical demonstrations on the engines and followed up by constant supervision, the nearest to ideal conditions will obtain.

Instruction in whatever form should be given, not only to engineers and firemen, but to round-house foremen, boiler makers, hostlers, hostler helpers, fire builders, engine watchmen, grate men and fire cleaners. And if officials of the operating and mechanical departments attend the classes occasionally, it will have a good influence, as well as keep them posted as to what instruction is being given and so be in a position to give support in having the instructions carried out.

Upon the round-house foremen, boiler makers and grate men should be impressed the importance of having the draft appliances, grates, flues and all parts that make for fuel economy, in proper condition when the engine goes out, and a clear understanding of what proper conditions are, should be insisted upon.

Hostlers, hostler helpers, engine watchmen and fire cleaners should be instructed in proper methods for building the fire, its care up to the time of delivery on the going out track, and the condition it should be in when delivered, proper methods of cleaning the fire, and when these men are in line of promotion to the position of fireman, they should receive the same instruction given to firemen.

The present method followed on most roads of sending a new man out as a student fireman to learn to fire from a fireman who possibly may be making his first trip for pay, is the poorest possible. It is the failure to do successful work when so started that causes so many to become discouraged and quit, and thus keep the service filled, particularly in a busy season, with green, dissatisfied and unsatisfactory men. And this practice brings about a method of firing by which the fireman keeps up steam when all conditions are right, but which is very extravagant in coal consumption, and when adverse conditions are encountered, results in steam failures. All this would be obviated if proper methods were followed from the start. It should be the aim to get these green men into the instruction car before they make a trip and give them a clear understanding of the theoretical part of the work, as well as an explanation, so far as possible, of the practical part, and then their first two or three trips, or more if necessary, should be made with the demonstrator instructor to give them a right start and a right start is of the greatest importance in any undertaking.

The demonstrator instructor should have only such territory and men under him that he can ride with each man at least two or three times a month and in this way keep them up to proper work. While it is a fact that the engineers and firemen receive the highest pay outside of official positions on the road, it is also true that the majority of them need, like other employees, direction and supervision.

No management would think of starting men in the shops without some direction and supervision, and the supervision would be continued at all times. The man, who by his faithful work, shows that he does not need supervision, is the one who is promoted.

The cost for material for repairs to our locomotives is only about 40% of the cost of fuel to operate them, while the cost of labor for repairs and terminal care is only 46% of the cost for fuel and labor to operate our locomotives, so it would seem reasonable to assume that the same amount of supervision be had over this labor and material as is had in shop management, but have we? No, far from it; it is safe to say that for every 20 first-class workmen in our shops we have a foreman. How many foremen or road foremen of engines have we on our 57,000 locomotives? No exact figures are obtainable, but we think that one road foreman for every 150 engines is a safe estimate. In the face of these figures no intelligent man can deny the fact that great saving can be brought about by closer supervision of the men on the engines. We believe there is work enough outside of the matter of fuel economy for the road foreman and it would be one of the best possible investments to train a corps of men especially for this work, and have enough of them so there would be at least one for every fifty crews.

While methods of instruction have been widely and ably discussed by this Club and other organizations, we believe there is still much to be said and particularly so as to just what the instruction should be.

The first essential is a well equipped instruction car, fitted up with apparatus and in charge of a competent instructor, who, where possible, should be a practical engineer. The difficulty of securing practical men as instructors will no doubt be great, but arrangements could be made with some of our technical schools to train men in the theoretical part of the work, or supply instructors to work with the practical man in the education of the men. In fact, we believe that the extension department of our State College would be only too glad to train men along these lines, could they be assured of openings for them, or the Scranton schools, through their railway department, would either instruct the men direct, or furnish instructors.

Besides apparatus for instruction on the principles of the chemistry of combustion, other apparatus should be provided for distilling the gas from coal, and catching some of it, and showing how it can be used to advantage, or how much or all of the gas may be lost by improper methods of firing, evaporation test apparatus in which some of the gas from the coal can be burned, and the economy of a slow rate of combustion over a rapid rate shown. Show that the rapid rate is the one where the black smoke is made, and that the black smoke is the carbon of the hydro-carbon gases, and represents a loss of 14,500 B. T. U. for every pound so escaping, also that with the black smoke is escaping quantities of partially burned carbon in the form of a colorless gas known as carbon monoxide, and that each pound of carbon so burned represents a loss of 10,000 B. T. U. That the formation of the smoke and the carbon monoxide is due to supplying coal faster than the draft appliances can supply oxygen through the medium of the air to burn it. The matter of draft and draft appliances and their adjustment should be gone into with the help of stereopticon pictures. These pictures should show the interior of the fire-box with the fire burning under different conditions, a view of the front end as well as the boiler in longitudinal section. The necessity of having the air come in through the grates to have the oxygen thoroughly mix with the fuel elements of the coal should be brought out strongly, and in this connection the necessity of swinging the door after each shovelful of coal is put in, should be impressed. Also that the air mixes best with the coal if a light fire is carried and the fresh fuel added in thin layers. Views should be shown on the canvas picturing the improper fire as well as the proper one. A fire with a hole in it should be shown, and the exact reason such a fire will not produce heat explained; also a clinkered fire, and what the presence of the clinker means and how to avoid it. A picture showing a tender properly coaled and trimmed should be shown, and any other views that local conditions make desirable. The importance of co-operation of the engineer and fireman should be taken up and strongly impressed on the men. Instruction in this way, or when this is not convenient, instruction by means of carefully prepared instruction books, will lay the foundation for the most important part of the work, namely, the demonstration on the engines in actual service. This world is certainly filled with many Missourians and a large number of them are to be found on our locomotives, so many in fact that I sometimes wonder if that State is not becoming depopulated by emigration, as so many of the men have to be shown. The demonstrator instructor should be an engineer of not less than two years' experience in that position, who thoroughly understands the theoretical part of the business, and who is able to take the scoop and fire an engine over the entire division if need be, to show that the theoretical part is practical in service, and when the two are combined far better results will be had than with either alone. Show how the fire should be built up at leaving time, so that when stirred out or broken up, as the start is to be made, that a clean bright fire will be had, one that is even in thickness over the grates, and only just heavy enough to stand the work the engine is to do. Show how if the fire is bright all over and not too thick, the air will come through equally at all points, the fire will not be torn in holes, and much less coal burned than if the start was made with a dull, heavy fire. That by firing light and often, and taking pains to break up the large lumps, and covering as large a surface as possible with each shovel of coal, and the door closed after each shovelful, that much less coal will be used, an evener steam pressure maintained with less labor, smoke eliminated in a great measure, and his work for the company more economical and satisfactory.

(The practice of leaving the door on the latch after each scoop of coal or after each fire to prevent smoke, is effective, is simply a second wrong to be made aright, the first error being in putting in too much coal at a time or too often. The truth is that there is a wrong understanding on the part of many as to how or under what circumstances black smoke is formed. Many believe that the smoke is formed on account of low fire-box temperature, when in fact it is impossible to form black smoke unless we have a temperature of at least 1800 degrees F., for the reason that the smoke is the unburned carbon of the hydro-carbons and does not become visible until it is separated from the hydrogen, and this separation does not take place until a temperature of 1800 degrees is had. At this temperature, if there is an abundance of oxygen present and in touch with these fuel elements, they will both burn, and only colorless gases will be produced. In most cases, where opening the fire-box to prevent smoke is effective, it is due to the fact that the cold air admitted above the fire in this way chills it below this splitting-up temperature and the gases escape in their compound form, and we then not only lose the carbon but the hydrogen as well, and will have to use considerable more coal to make up for this loss.)

Show him that the proper time to add fresh coal is after the gases of previously added coal have all been burned off, and the fire is burning with that white incandescent heat that is so blinding when you look at it. Call his attention to the fact that the coal must be added at just the right time, and if so added there will be no danger of the fire getting away from him. This is one of the hardest things to teach a man and can be done only by practical demonstration. The writer has had many firemen say: "I did not believe it possible to fire an engine with such a light fire and would not have dared to try; but now that I see it can be done, I am going to do it." Abuse of the fire on the part of the engineer in allowing the steam to slip, leaving the lever down too long in starting the train, or failing to hook up when tippling a hill, or upon striking a sag or flat place, is often the cause of heavy fires and extravagant methods of firing followed by so many firemen. If the fireman has the experience of having his fire taken away from him once or twice by such practice, he will ever afterward be inclined to go "loaded" for all comers, as he would rather be censured for having too much coal in the fire-box than for not having enough, even though the heavy fire will not produce as much steam. The harmfulness of this wrong practice on the part of the engineer should be pointed out to him very clearly and proper methods of handling his engine insisted upon. The importance of shaking the grates to keep them free from ashes and clinkers as far as possible, should be impressed on the fireman, but at the same time he should be cautioned not to shake them too often or too hard. The fireman should be taught to use his head, to figure ahead and have the condition of his fire right for different parts of the road, so that when a shut-off is to be made the fire will have burned down so that if the engineer has figured to have room in the boiler for water and increases his water feed before closing the throttle (if he does not do this he should be instructed to do so), the pops will not lift and black smoke will not trail over the train. While it is quite proper and essential to let the fire burn down under these conditions, he should also be impressed with the necessity of not going to an extreme, so that when steam is to be used again there might be a failure of pressure, or more coal required to build the fire up again than was saved by allowing it to burn down.

We think it is understood that all efforts to fuel economy must be subservant to the conditions necessary to pull the tonnage and make the time required, and if one method will do this and another will not, the most effective method must be followed, although it has been our experience, when the engine is in even fair condition, the best results will be had when the light and frequent method of firing is followed. The engine crew must work together to get the best results, so the instruction should be understood alike by them. They should figure, upon reaching a terminal, to have the fire in such condition that after the engine has been left on the terminal track by them, the pops will not open and waste a lot of fuel, neither should the water be left too low or the fire so low that it will die out, particularly at the flue sheet, before the engine will have been taken care of by the hostler or engine watchman. The fire, water and steam pressure should be as outlined in a previous paragraph on "Condition of fire at completion of trip."

The exact relation of the traveling engineer or road foreman to the demonstrating instructor, or just what his title should be, is a matter that will have to be worked out locally. The title certainly should not be traveling fireman on account of lack of prestige such a title would produce. and the duties of this man should be apart from those of the road foreman.

On the Erie this scheme is being worked out experimentally on two divisions by a man on each division with the title of supervisor of locomotive operation, who has full authority over the men so far as the proper operation of the locomotive is concerned, and who looks after the draft appliances as well as all other parts or conditions that make for fuel economy, and they are getting remarkable results.

We believe that no man should be placed in the position of demonstrator instructor who cannot take the scoop and demonstrate every point, or if unable to do so, point out clearly what improper condition prevents proper results being had. While we do not believe he should fire an entire trip at any time, unless in case of emergency, he should fire far enough to demonstrate to the doubting ones that the method of light and frequent firing can be followed, not only for a few miles, but for many, not only in light service, but in the heaviest kind of service. He should also impress upon the fireman when he takes the scoop that it is not for the purpose of relieving him of his work, but is purely instructive, and he will be expected to follow methods and get results as shown. In riding on poor steaming engines, to determine what the cause of steam failure is, he should watch the operation on the part of the engineer, test for valve and cylinder packing leaks and fire the engine himself to determine accurately where the trouble is. The engineer should be instructed on these points as well, so that the common report of "engine don't steam," will be supplemented with an explanation of "why," so the roundhouse foreman will know what to do to overcome the trouble. He should have the supervision of the hostlers, fire cleaners and engine watchmen and the condition of the fires at terminals. His report on quality of coal used and manner of charging it to engines, should have much weight.

The value of the papers read and discussed at the conventions of the International Railway Fuel Association, and the Traveling Engineers' Association is great, and every railroad management should allow their traveling engineers and fuel men to attend and urge them to take part. It would be time and money well spent if these men were also to become members of the Railroad Club in their immediate vicinity and afforded an opportunity to attend meetings, as it would broaden their knowledge and increase their efficiency.

In conclusion, we wish to repeat that we are very much in earnest in all we have said, and hope it will be the means of some deep thought and proper action on the part of those who are in a position to bring about these changes. Gentlemen, I thank you.

MR. WM. ELMER: I move that the Club offer a hearty vote of thanks to Mr. Kinyon for his very instructive paper.

The motion was seconded and carried by unanimous vote.

PRESIDENT: We have men here capable of discussing this paper and we would like to hear from them. To open the discussion I will call upon Prof. A. J. Wood, of the engineering department of State College.

PROF. A. J. WOOD: I suppose the title of this paper might read, "Hot Shot From the Firing Line;" and while some may say that this is what we are doing every day, it seems to me there are many things taken up that deserve most careful consideration.

If we can save, say 1% on lubrication, 5% in selection of fuel, 5% from better firing, 5% by improvements in front end, 5% from brick arch and prevention of scale, and so on for all the possible places, and could secure them all in one locomotive, we might run on very little coal. My point is that each condition must be considered by itself and if we get say more than 15% saving by cutting down the losses to a minimum, something was radically wrong to begin with.

I spent a day with Mr. Kinyon last summer, where I observed the working of locomotives fired by men coming under Mr. Kinyon's instruction, and can say without prejudice that he has got results in the way of better combustion. The absence of smoke does not *always* indicate economy. It may only prove air excess. Black smoke represents not over 1% of the heat in the coal. On the other hand, absence of black smoke is one of the best indications of good combustion. Closely allied to the general question of smoke is the chemical make-up or composition of coal. We find those who have studied fuel economy for years disagree materially on the nature of the volatile matter and its effect on the general question of economical combustion. One of the present needs is a systematic study of the coals of Pennsylvania, both as to their composition and their behavior in a furnace.

Those who have studied the problem know that the fireman is limited in getting results from much of the coal put into his hands. The author of the paper calls attention to the fact that if a uniform grade of coal can be selected and the firemen become familiar with its characteristics, they will handle it to the best advantage. In this suggestion alone lies a possibility of much saving. Again, one engine will burn a certain grade of coal much better than will another. An ideal condition would be to reduce all the tests and experience down to such a basis that having given a certain chemical composition of the coal, with a determined rate of evaporation, that coal is worth, say, a dollar a ton at the mines. Coal could then be bought for one section with more uniformity and a promise of better results. But this is a condition which we have not reached, partly because of the demand and supply of coal.

The instruction of firemen should be taken with the precaution noted in the paper, that to be effective such instruction should be accompanied with actual demonstration. Reference is made to the extension work of the School of Engineering, the Pennsylvania State College, and this leads me to say that instruction is being carried on, under the direction of Dean Jackson, by one of the largest railroad shops of the country. About two hundred regular apprentices, under college supervision, are taking regular courses for six hours a week, the hours of instruction coming during the time of the day when they are receiving their regular wages. The college stands ready to offer a similar service elsewhere. Noting the suggestion in the paper, and applying it to the question under discussion, my notion is that if we can take a boy at the age when he is beginning to form some idea of why a common coal-oil lamp burns without smoke and then lead him to see what conditions may produce imperfect combustion—in a word, teach him the theory of fuel economy and smokeless combustion—we can give him the right start. This should be followed by taking your demonstrator instructor out with the boy giving him the application, by light and frequent firing. The result should prove a saving in fuel over present methods. But instruction needs not be limited to beginners. On the theory that an intelligent fireman is worth more than an ignorant one, the State College has given lectures to stationary firemen, using demonstration apparatus somewhat similar to that used by Mr. Kinyon with the result that the men hearing the lectures are reported to be taking more interest in their work. The college may also be of service along similar lines with locomotive firemen. Its function is not limited to one method or to one center.

With your permission I will briefly refer to a saving of about 15% in the coal consumption in the compound locomotives on the Santa Fe using two super-heaters, one for the high and one for the low pressure cylinders. In the Buck-Jacobs type of super-heater, of which I am speaking, the high pressure super-heater is directly in front of the front head sheet and the low pressure heater in front of that. As you know, the aim has been to get the advantage of super-heat without exceeding a temperature of 450° F. in the cylinders, above which temperature difficulties arise chiefly in supplying proper lubrication. Making an analysis of one of the runs to determine what gain in steam consumption is due to super-heating, I find that with the 22° F. super-heat in the high pressure cylinder, a gain in that cylinder of 2.4%, and with 93° super-heat in the low, a gain of 7%, making a total of 9.4%. The test gave 10% saving in steam, and a range of 11 to 19% saving in coal. Although not enough to prevent condensation (which theoretically should be the case), it is evident that the greater gain comes in the low pressure, due primarily to the fact that with the low pressure more super-heat can be secured without exceeding the 450° in the cylinder.

One thing more: if you will take the heat contained in the 3.1% moisture in the exhaust of the high pressure and apply it to further super-heat above the 22°, coming out with saturated steam, a gain will be found of 7% instead of 2.4%, the temperature in this case reaching 470°. Of course, this would require more super-heating surface. If limited to 450°, the gross gain would be about 5.5%. Turning to the low pressure cylinder: if we used the heat (as before) in the condensed steam to further super-heat in the low pressure cylinder, the calculated gain will be 17%, but the temperature is 520°, which is much too high. Restricting the temperature to 450°, the gain is about 12% instead of the 7% with the moisture in the exhaust. All this goes to show that relatively a greater gain theoretically can be effected in the low than in the high, if we are limited in the maximum temperature in the cylinder, to, say, 450°. These figures show only the principle involved; a complete analysis would require us to take in the question of cylinder condensation.

These tests on the Santa Fe open up an important way of increasing the economy, the final results of which will be watched with interest. There are yet many difficulties to be met and troubles to be overcome.

PRESIDENT: Mr. John R. Alexander, General Road

Foreman of Engines of the P. R. R., is with us and we would be pleased to hear from him.

MR. ALEXANDER: Mr. Chairman and Gentlemen:—It is a little embarrassing to try to analyze or criticise such an able paper as we have here tonight. I am very much intlerested in the subject, and especially interested in seeing the man higher up get what was coming to them, for the reason that a good many of these men are after the man on the firing line 365 days in the year, and I hope they will appreciate what has been said in regard to putting locomotives in condition and to the supply of coal.

We think that if a fair to good, but most of all a uniform quality of coal was furnished, and they would stop putting on a poor quality of coal that prevents a good engine from making the required speed over rolling grades, the result would be surprising. As it is, when many different kinds of coal are furnished I do not think if we had college professors firing the engine they could get much in the way of fuel economy or in the prevention of smoke, as is required by the usual city ordinances. If they have a change of coal each six days on the same engine, especially when that change is radical to the extreme.

I would like to ask Mr. Kinyon if we are entirely wrong in thinking lump fuel in from 4 to 6-inch cubes is objectionable. If I remember aright, the testing plant at the St. Louis Exposition made some elaborate tests of fine coal, mixed fine, and lump and good lump coal, and the outcome was that the best evaporation was had with the lump coal in from 4 to 6-inch in size. In other words, it was not essential to break it up as fine as suggested by the writer.

The question of nozzle and diaphragm has been mentioned, and there isn't anything more important than the proper adjustment of draught appliances. There are but a few roads that I know anything about that many engineers doesn't think some particular size or style of nozzle is the best for the engine, and a sure cure-all for all kinds of steam failures. It is unfortunate that in many places they let the engineer or engine house man determine the adjustment of these parts. In the early stage of a new type of engine coming on tthe road it should be determined by some proper authority the proper size of the nozzle and the best arrangement of diaphragm for burning the average grade of coal furnished, after which these parts should be the last thing to change to get results.

Another thing he mentions is the petticoat pipe. Does he mean the drop extension of the stack or smoke bell in large engines that do not have any room on the outside for size of stack? We do not call that a petticoat pipe, but agree with him as to the removal of all old style petticoat pipes that extended down over the top of the nozzle.

In the matter of fuel economy as a general proposition, I really believe, as far as the enginemen and firemen are concerned, that the engineman is responsible for more waste of fuel than the fireman. In regard to the matter of instruction and demonstration as outlined in the paper, I think nine parts of it ought to be demonstration and one part instruction, and that one part carried to them out on the road. The only rules that should be placed before them ought to be short, something like "do not swear," short and to the point. The only rule that the fireman of average intelligence needs is to carry a light fire, swing the door between each fire and "Do not let the safety valves blow off steam, from one end of the road to the other." This with proper handling of the engine, on the engineman's part, which includes maintaining the proper amount of water in the boiler,will save all the fuel that can be asked of them. I have seen efforts to save coal, when firing with too little coal, resulting in a waste of coal. A certain amount is necessary to do a certain amount of work, and it is up to the fireman to fire at the right time, all of which is outlined in the paper very thoroughly. The thought that he is helped in carrying a good fire by the theoretical knowledge of combustion does not appeal to me very strongly. How could a fireman on one of our large modern engines know how much air does or should go into the fire-box? He has no means at hand to regulate the supply, as air openings located under the grates are wide open under all conditions; in fact, one of our best steaming class of engines was about worn out before the master mechanic found out how much air openings they ought to have in the ash pan. At the same time I do not want you to think for a moment that it would not be worth while for any young man to dig out all kinds of information in regard to all kinds of work, but when it comes to stoking 30,000 pounds of coal in 10 hours, or 100 miles, there is but little time to remember much of the printed matter you have forced that fellow to study in addition to carrying the light fire and not letting the engine blow off.

The importance of construction work may be illustrated by the methods employed when cleaning fires. Sometimes I think it would be as profitable to examine the contents of the ash car and see the amount of good fuel wasted as it is to visit the scrap iron yard. It is not a common practice when engines arrive on ash-pit tracks for the fire cleaners to first lower both drop grates and knock out all fire and dirt on the drop grates and then to hoe out through these openings both good fire and cinders from over the shaker grates. On the other hand, what should be done, whether the engine comes in with a big or little or clean or dirty fire, is first, to shovel out all cinders over the shaker grate and then to pull the good fire from over the drop grate back on the shaker grates, and then lower the drop grates and properly clean the front and back ends, then raise the front drop and push good fire over the front grates and rake the remaining clinkers out through the back drop, and then rebuild the fire over the front half of the grates. This method, which I have no doubt the writer of this paper will agree is the best and most economical when cleaning or banking fires, does not entail much instruction, but does entail a great deal of supervision to get results.

While I can fully concur in the several recommendations to keep in good condition all boiler and mechanical appliances, I would be all mixed up to entirely agree with the suggestion of always closing the fire door between fires. I am familiar with some fairly accurate boiler tests that show that under ordinary working conditions, with a good light fire and same grade of coal, there is considerable advantage in leaving the door against the latch.

Is it not a fact that the fire-box is, first of all, a gas producer and with the frequent changes in working conditions, where the fire cannot be as quickly changed as the conditions demand, when a portion of the air necessary to support combustion, even if cold should be admitted above the fire, as for instance when the engine is running fast and working hard at 30 or 40% cut off, the firing must be rapid and a continuous performance, which means that the door is wide open most of the time, and while we understand that cold air does not aid combustion but rather whitewashes the low temperature gases, the door slightly open as when on the latch serves a two-fold purpose, as in a measure it prevents a tendency of the strong draft to pull the fire either in holes or towards the flues, and second, to reduce the amount of gas produced by checking the rush of air coming through the bright fire, at least until the lighter volatile gases are consumed. It may also be true that when the working condition could be made uniform it would be possible to obtain the happy combination of a bright fire of proper thickness which would in turn make the gas producer a perfect and smokeless consumer. I fear, however, these conditions are more ideal than practical.

Another point in conclusion: I would hesitate to endorse the suggestion to have the work of fuel economy placed under the supervision of an additional force of experts. What good reason is there why all work of this character, so far as relates to locomotives in service and enginemen and firemen, that could not be well taken care of by the road foreman of engines or traveling engineer? If they are not experts, they should be, if not they are not the right men on the job; but I do not encourage too many bosses, which always means a division of authority and no one responsible for anything.

PRESIDENT: Perhaps Mr. Ehner, Master Mechanic of the P. R. R., will tell us why they do not find out.

MR. WM. ELMER: I must say Mr. Alexander hit the Pennsylvania Railroad about as hard as any of the rest of them in that remark. It was left for the St. Louis testing plant to bring out the fact that our heavy freight engines did not have near enough air getting in the ash pan.

One or two points I made note of while the paper was being read. In regard to brick arch, requirements as to stay bolt inspection on the railroad with which I am connected seem to me pretty nearly prohibitive of the use of any brick arch. A seven-day inspection period would mean perhaps that we would have to tear down and build up more dollars' worth than we could save in the coal we burned in those seven days. I have not had an analysis made of the cost of the arches for our heavy engines, and if

Mr. Kinyon has any information on that point I would be obliged to him for it.

It may be of interest to the members of the Club to refer for a moment to a demonstration to which I have had attention called recently in Pittsburgh concerning the consumption of pulverized coal. In the Phipps' Power Building there is a Babcock & Wilcox boiler rated at 250 horse-power which has been burning pulverized fuel for several months. A few years ago the Pennsylvania Railroad attempted to burn pulverized fuel and the experiments were practically a failure. There was a material deposit of slag on the heating surfaces, which was almost like an enamel baked on and had to be chipped off. But the results on these B. & W. boilers seem to lead to the belief that perhaps there may be a future for the burning of pulverized coal in a locomotive fire-box. The people who are back of that installation have a set of drawings of one of our boilers and are now working upon a scheme to see whether they can put in an apparatus powerful enough to do the work. The quantity of coal which has to be consumed to take one of our heavy trains over the mountainous grades amounts to considerably over 5,000 pounds of coal per hour, and while their plant at present has nothing like that capacity, they believe it is a possibility to so design the parts that they can be placed within the physical limits of the size of a locomotive fire-box.

Mr. Kinyon also made some remarks in regard to the accurate weighing of coal when engines were starting on the run. It seems to me that would be a very desirable thing to do if you could also weigh it at the other end. Mr. Kinyon may have some method by which the amount of coal left in the tender to be credited to the crew can be arrived at, but it has always seemed to me that unless we had some such means it would hardly be worth while to accurately determine the amount of coal issued. The question is a very live one, because the railroads generally feel that if a workable method of determining how much coal each crew uses could be arrived at, the work of instructing the men would be productive of better results and a good deal more economy could be obtained, about which we are now in the dark.

PRESIDENT: Mr. Scheck, could you add anything?

MR. H. G. SCHECK: I certainly appreciate the paper we have heard read this evening. It is a step in the right direction, but if the engine is in good condition when leaving the terminal, before going out on the road, that is, to have the steam pipe joints perfectly tight and no steam leaks at pistons or valve stems, the cylinder packing and valves in good condition and the engine perfectly drafted, I think, without any demonstration on the road, if we could get the engine in this condition we could reduce the coal consumption considerably.

PRESIDENT: Can we hear from any other gentleman on this subject?

MR. C. A. RICHARDSON: The responsibilities and requirements of enginemen in the last few years have been increased, and they must of course be men of ordinary intelligence capable of grasping and absorbing matters of instruction that pertain to their line of business. It has been my good fortune to be an engineman for a good many years and have, of course, noted in my experience as such the different methods of firing, and I have found that the lighter a locomotive can be fired the better results follow. But I do contend that an instructor or demonstrator should be one in fact as well as in name. Unfortunately, some of our instructors or traveling firemen or engineers are addicted to the habit of riding to a great extent on passenger engines, and they generally get on at the starting point where the conditions of the engine are most favorable and ride a distance before the engine commence to fail, and they get off and say she is all right, instead of going the whole length of the run, so that the true facts about the engine and enginemen can be demonstrated to them. If there is a failure after they get off they say it is due to the engineman.

They should be men fully competent to fill the positions, and I believe enginemen are not opposed as a rule to such instructions for the betterment of the service. It is to their advantage to get these instructions and take advantage of what will lessen their labors and increase their efficiency.

Of course we all understand that the question of economy is one that has been moralized and theorized upon until it has almost been worn threadbare. But it can stand a great deal of talking about yet. It might be applied to a great many other phases of life on the same line as has been spoken of by the gentleman tonight.

I want to say this, however, that the paper read by the gentleman is a very complete one and deserves our thanks and thoughtful consideration. It is one that should be in the hands of every one who is connected with locomotive service. It can do no harm, but it can do a great deal of good.

PRESIDENT: Mr. Turner, can we hear from you?

MR. L. H. TURNER: Owing to the fact that I did not have an opportunity of reading the advance copy of Mr. Kinyon's paper, I hardly feel competent to discuss it intelligently. I am satisfied, however, that Mr. Kinyon thoroughly understands his business, but in all kindness to him, will say that every master mechanic and round-house foreman should be thoroughly familiar with all of the ideas presented by Mr. Kinyon, and if they are not familiar with them, they are not competent men in their positions.

Our line has not had the benefit of instruction from any representative of a state college, or any other educational institution. We, however, have a very active board of educators who operate under the title of the Brotherhood of Locomotive Firemen, and our experience has been that they devote much energy and thought in trying to see how little they can do, and how much they can get for it. I feel that Mr. Kinyon has omitted one important point in his paper, and that is, to inform us as to what methods we shall pursue in order to have firemen follow his instructions and perform their duties in the same manner when he or some one else is not watching them as they do when they are being watched.

We would like to know what to do in order to have men refrain from going in on sidings, putting in a big fire, then placing themselves on the seat box with the dampers open, fire door shut, causing the engine to pop continuously until such time as the fire has died down sufficiently so that some steam can be generated.

If Mr. Kinyon will devise some method by which we can obtain these results, and will also tell us where to find men who will perform their duties as well as they know how, and do so without being watched constantly, he will have proved himself to be a valuable adviser to railroads in general. I would also like to see some figures as to the amount of fuel consumed by the fireman before he receives the instructions advocated by Mr. Kinyon, as compared with the amount used by the same fireman after he has been thoroughly instructed. We all know what should be done, but our principle difficulty lies in getting it done in the proper manner.

PRESIDENT: Mr. Kinyon, will you close the discussion?

MR. KINYON: Answering Mr. Alexander in regard to the size of the coal in the St. Louis Exposition tests, I hesitate to question the facts as given and do not for a moment doubt the truth of the statement that they got results which led them to believe that 4-inch cubes were the best size, yet I think there is some different condition between the operation of a locomotive on their stationary plant and one in actual operation on the road that brings about the difference. I am not prepared to say just what the difference is, but I do know from experience, and I believe I can point out to you that from a reasoning standpoint that it is not possible to get as good results from those large cubes of coal as it is from smaller ones. If you will figure up the amount of surface exposed to the action of the air on a lump four inches each way, and the surface exposed to the action of the air on a number of cubes 2 inches square to amount of the cubical contents of a four-inch cube, you will readily see that we are going to get, in coal well broken up, a larger surface of contact, and in combustion you must have the air in actual contact with the fuel if combustion is to take place. And not only that, but when you place a number of large lumps on the grates, in order to get a solid fire and do away with the large openings through which air will come freely, you must make a much thicker fire than would otherwise be the case. And I am confident and ready to go out at any time and demonstrate in a practical way with coal broken up to 2-inch size I can fire an engine with far less coal, have it easier for myself and keep an evener steam pressure than a man with 4 or 6-inch cube coal can, I don't care who he is or what his ability, that size coal will handicap him.

In the matter of petticoat pipes, the remark in the paper of course did not apply to the extension of the stack down into the front where with the large front ends we are compelled to cut out some of the volume of the front end by putting in plates at the top and then, of course, the stack must be brought down to meet it. This really gets us down with the base of the stack in the front end, and a bell mouth casting is attached to the base, so that the stack is really the same height above the nozzle as in the smaller front ends where the stack is wholly outside the smoke arch and no petticoat pipe used. It is the use of the petticoat pipe with a flounce on it, and supported by irons from the smoke arch, that we do not believe in. On the road I am connected with we had some engines with no petticoat pipes and some others of exactly the same size and style, with pipes, and those without the pipes gave better results in fuel economy, steaming properties and in ability to fire them without smoke.

Referring to the matter of the instruction of men in the theoretical part of their work, Mr. Alexander says they have been running some engines on his road for some time, and have only discovered lately that they did not have the proper openings in the ash pan for the best results. Why didn't they? Simply because the engineer or fireman, the men who are in a position to know, did not possess the proper amount of knowledge to determine just why they were not getting better results from these engines, and consequently were not able to give the master mechanic information. That is why I say we want to educate the men on the engine as far as possible in these theoretical things, so that they can, as they see certain results produced, determine by a process of reasoning or elimination just why they are not getting better results, and then be able to make an intelligent report.

In the matter of the brick arch removal for stay bolt tests, on the road I used to run on, the Chicago, Milwaukee & St. Paul, I don't suppose the stay bolt tests were as exacting as they are now. I do not know that they are as exacting in that locality now as they are in the State of Pennsylvania or New York. I was out on the old road last summer and they told me in some districts a brick arch will last six weeks, in some perhaps two months, and in some other districts where they burn a certain class of coal they have to renew it every week. But in a talk with Mr. Parish and Mr. Moore, of the American Arch Company, recently, I was informed their sections are now put up so that if your tests are to be made as often as each seven days, a row of bricks next to the side sheets can be removed and the same bricks replaced. They are so arranged that they will not melt or fuse together; in fact, are designed with an idea of preventing this, so that they can be removed for inspection without disturbing the center rows and the brick replaced. The expense would be simply the cost of the labor for removing the section of brick and replacing them.

In regard to weighing coal, while at Milwaukee last May I had occasion to investigate their methods of coaling engines at the West Milwaukee plant of the C., M. & St. P., and they have a coaling station there which is simply an immense bin on a scale, with an automatic arrangement so that when an engine is coaled the weight of the coal in the bin before the chute is opened is known and when the chute is thrown up the remaining coal in the bin is weighed and substraction is made by automatic apparatus and a ticket printed showing just how much has been delivered to that engine. Some such means, I believe, is the only solution to this matter of getting accurate information as to the amount of coal put on an engine. It involves a big expense, and means that we must have that sort of coaling station at all points, When an engine comes in, if it is in chain gang service, the tank is filled up, and the amount necessary to fill the tender charged to the man bringing the engine in.

Mr. Turner asks for some way to get the men to do as well when we are not on the engine as they do when we are. I had a crew running into Pittsburgh on the B., R. & P. that it mattered not whether I was on the engine or on the train, or not, that crew was always doing business right. I am sorry to say that this crew is an exception. The only solution of the problem of getting men to do as they should under all conditions is to have enough supervision, have enough men in these instruction and supervising capacities to keep the men on the engine on their jobs all the time. With a man for every fifty engines, and a limited district, he is able to drop off a train and check them up unexpectedly. That is the only suggestion I have as an answer to Mr. Turner's question.

He asked if I had any figures as to exact results obtained from the instruction. I am sorry to say I have not. A number of years ago the matter of fuel economy was taken up with the

B., R. & P. and the then general manager smiled and said "The B., R. & P. sells coal." When we took hold there were no accurate figures of what had been done, so no comparisons could be made.

PRESIDENT: If Mr. Kinyon has raised any point in his answers that any of the members want to take up, the meeting is still open.

MR. A. STUCKI: To study this problem in its principles we can best learn from stationary boiler practice. There are a great many boilers in our Pittsburgh district that will emit black smoke and lots of it, no matter how careful the firemen are and where there is black smoke there is a waste of fuel and there is a menace to health and comfort. I think most of us will agree with me on this point.

I know of several such boilers which were changed in an inexpensive way by simply admitting heated air to the top of the fuel without adding any stokers and they ceased to emit black smoke entirely except during the period of firing. I know also of a large power plant down on Brunot's Island, which never makes any smoke and eager to know why I personally investigated the case and found that again a sufficient amount of heated air is admitted to the top of the fuel bed, and in addition to this, stokers are used.

The first feature can easily be applied to a locomotive in various ways and a great deal of credit is due to the Central of Georgia Railway in this respect. The coal there costs more than in Pittsburgh. Their Superintendent of Motive Power equipped some locomotives with a hollow arch extending from the grate upward. The iar is then heated in passing through this arch and is delivered to the top of the fire just where it is needed to burn up the volatile gases. These engines burned 102 pounds of coal per 1000 ton miles, while the same engines unaltered, with the same crew, same load, same track, etc., burned 142 pounds per 1000 ton miles. This is a tremendous saving and was accomplished in such a simple way. For further details see *Railroad Age Gazette* of August 5, 1910.

In the matter of pulverized coal, we also have to learn from stationary practice, as Mr. Elmer has just mentioned. We now know that coal in that form is quite successfully burned in stationary boilers. I know of a large plant in Erie using this method exclusively, and we may find ways to apply the experience thus gained to locomotives by and by.

But whatever we do, we should not blame the firemen for all the trouble and Mr. Kinyon is quite right when he says that the man higher up has to take a hand.

MR. ELMER: I do not want to stick pin holes in this splendid paper, but I want to bring up one point which Mr. Kinyon may have glossed over a little, in regard to this stay bolt inspection where they have brick arches. The method described by Mr. Kinyon of removing side bricks I happen to be familiar with. But the point which he did not bring out and which it is only fair to have brought out, is that those bricks are hot and some time must be allowed for the engine to cool off. We have figured that an engine is worth about $2.25 an hour, therefore if it has to stand around many hours waiting for those bricks to cool off there would not be so many dollars left to pay for the coal that is going to be saved.

MR. S. J. GUTIERREZ: I would like to ask a question: Does he not find that a great deal of time is lost breaking up coal which could be used by the fireman to advantage in keeping up steam on the locomotive? And would it be of any advantage to have this coal broken up into two-inch cubes on the coal wharf and relieve the fireman?

MR. A. J. HARNER: I have listened to Mr. Kinyon's very interesting paper and must say, "He certainly knows his business." He thoroughly understands economy at the terminals, before and after the engine has completed its trip.

As far as firemen are concerned out on the road, I find it is not necessary for them to understand combustion or the chemical composition of coal. All they want to know is, how to place the coal in the fire-box in order to get the best results.

Mr. Kinyon stops after he builds up the fire and starts again after the engine completes its trip. There is a question I would like to ask—what method does Mr. Kinyon teach out on the road, or in other words, how does he place the coal in the fire-box?

MR. KINYON: I regret very much that some representative of the brick arch companies is not here to answer Mr. Elmer's questions. While I know from the actual handling of engines on the road that an arch is a very desirable thing, yet never having had the care and responsibility of engines at terminals I probably do not realize the difficulties encountered in that care as I ought.

The gentleman in the rear spoke about the size of the coal. The trouble with lumps, if it is necessary to break them up, and we believe it is, is that with the method of firing which I have tried to explain, oftentimes a number of lumps come down behind the coal gate, and with the light fire, which is productive of fuel economy, it is necessary to put coal on at the right second or the fire will get away from you, and if the fireman's attention is taken up breaking coal rather than getting it into the fire just at the right time, he is going to have extravagance rather than economy. For that reason I think it would pay to have the coal broken up to firing size before being placed on the engine. There is a difference of opinion as to what that size should be, but I am ready to demonstrate that smaller size coal gives better results.

I feel rather humbled by the remark of the gentleman in the center that I have left out the most important part of the subject and only hit each end. I think if the gentleman had a copy of the paper before him he would find that in the body of the paper we have mentioned several times the method as being a light and frequent method of firing, that the coal be added in small quantities and in thin layers. And to have those additions of thin layers, the coal must necessarily be broken up. As to the exact methods of firing, you cannot make any hard and fast rules as to the exact thickness of the fire to be carried. It varies with conditions. Have the fire built up heavy enough to stand the work the engine has to do and no heavier. And let it be of one thickness all over the grates. If you have an engine so drafted that you find in actual work she steams better with a heavier fire at one part of the grate than another, get after the draft of that engine; there is something wrong.

My method of firing is to start with a fire well broken up, even in thickness, to endeavor to have maximum pressure without popping, and commence firing. The coal should be well broken up, the door opened quickly and the shovelful of coal scattered over as large a surface as possible, commencing, say, along the right side of the box. Then let the next scoop full go along the left side, and the third scoop full, if possible, across the front of the box, closing the door after each shovelful and so on. The scattering of coal is something all men cannot do. There is a great knack in handling the scoop. The mistake many firemen make is in lowering the right hand as the coal is delivered in the fire-box and throwing the coal up, with the mistaken idea that the draft will distribute the coal. It will distribute it, but it will put it just where you do not want it. You want it on the thin places, and that is where the draft is coming through strongest and will blow it away and pile it up on the thick places. He should have the right hand high and let the bottom of the scoop strike the bottom of the door. This helps to spread the coal, it relieves the body from the muscular effort of stopping the momentum of the shovel, and if the man can be taught, just as the bottom of the scoop strikes the bottom of the door, to give the shovel handle a little twist, he can make the shovelful of coal spread out fan shape, and you will be surprised at the large surface covered with a single shovelful of coal.

The great trouble I find with firemen is that they are afraid the fire is going to get away from them. They are crowding it all the time and they seem to be happy only when they have the pops up and the black smoke rolling. When I started firing several years ago, the engineers said to me: "Son, you keep the black smoke a-rolling or there will be trouble." I was young and strong and I did it. There is a strong belief on the part of a majority of enginemen that it is a necessity to have black smoke to keep an engine hot. There are sometimes conditions where it is necessary, but I do not want to take time to go into that at this meeting, but if any one cares to write me in connection with this point I will be pleased to send them an explanation. But the method of firing is simply light and frequent firing, supplying the fuel no faster than the draft supplies oxygen through the medium of the air for proper combustion. We have some men who after a demonstration of this kind of firing go out and—it may seem a reflection on previous conditions to say this—and get the efficiency with one-half the fuel, but I know of one or two cases where that was done. I do not hesitate to say that an average of 20% saving is possible in all cases.

Replying further to Mr. Alexander: I regret very much that Mr. Hayes, of the Erie, who most of you know, is not here to give Mr. Alexander some figures on what they have found to be the percentage of unburned carbon in the ashes on their road. They have investigated the matter very thoroughly, have collected and analyzed samples of ash from all their ash pits at division terminals and while I do not at this time recall the exact figures I do recollect that they were surprising.

I think that Mr. Alexander and I agree perfectly as to the proper method of cleaning fires, as reference to that part of the paper will show. I also agree with him in the matter of much supervision of this part of tthe work, particularly where much foreign labor is used, and I think that much of it is such.

In connection with his remarks on the matter of closing the door after each shovel of coal, I still contend that if they get apparently satisfactory results by leaving the door on the latch after each fire, that more economical results would be had if the nozzle were opened a little and the door closed. You know that when an engine is about to pop it is the practice to open the door to prevent the pop lifting, and if this is effective, and most of us know that it is, it is hard for me to understand how leaving the door on the latch will be economical. The situation reminds me of the toper who was asked why he drank whiskey in the winter time, replied that it was to keep him warm, and when asked why he drank it in the summer said that it was to keep him cool.

I cannot concede that opening the door reduces the amount of gas produced from the coal, as the amount produced does not materially depend upon the air coming through the fire, but rather upon the fire-box temperature and as these gases commence to evolve at about 350° and are all off at 900°, the reduction of air through the fire cannot effect their production unless the fire is deadened so much by the admission of air through the door that the temperature is reduced below the evolving temperature. I know that an engine can be so drafted that the door can be closed after each shovelful of coal in the hardest service and more economical results had than when the draft conditions require the door left partly open for the reasons given by Mr .Alexander.

Referring to Mr. Alexander's concluding remarks, I would say that if the force of traveling engineers can be increased to a point where they can look after the matter of fuel economy effectively, well and good, but I doubt if this can be done, though the two forces of experts could quite conveniently come under the same department head where the conflict of authority and responsibility would not occur. This is the plan that is being worked out on the Erie Railway and is working very satisfactorily so far.

PRESIDENT: I presume that closes the discussion and I am sure we have been well entertained. We will now listen to the reports of the Secretary and Treasurer.

SECRETARY'S REPORT.

To the Officers and Members of the Railway Club of Pittsburgh:

Gentlemen:—Your Secretary is pleased to submit below the ninth annual report of the Club for the year 1909-1910.

Our membership reported last year was 715. There have been received into membership during the past year 176, while two members were reinstated. There have been lost by suspension, resignation, loss of address and death during the year 141, making the present membership 752, an increase of 37 over the previous year. It is to be regretted that we are compelled to show so many members suspended for non-payment of dues, but those who have been dropped received the usual notices and their indifference makes it advisable to drop them until such time as they may see fit to meet the delinquency and ask for reinstatement.

The events of the year should certainly be gratifying to the officers and members, which is due to the co-operation of both.

The papers presented were of especial interest, which accounts very largely for the good attendance at our meetings. It will also be noted that the advertising in the Club Proceedings is steadily increasing and our "advertisers" have shown their loyalty by continuing to give us their support. Their assistance depends very largely on the success of the organization.

We had the misfortune to lose by death during the year:

Geo. T. Barnsley,
Wm. W. Colburn,
G. H. Davis,
Wm. Metcalf,
Wm. J. Post,
E. J. Randall,
Fred. M. Robinson.

The following is a summary of the membership, financial condition, etc., for the year up to and including this meeting:

MEMBERSHIP.

Reported last year	715	
Received into membership during year	176	
Reinstated	2	
		893
Suspended, non-payment of dues	83	
Resigned	43	
Loss of address	8	
Removed by death	7	
		141
Present membership		752

FINANCIAL.

Receipts—

In hands of Treasurer last year	$1,070 32	
From advertising	2,028 10	
From dues	2,178 00	
From sale of Proceedings and other sources	171 48	
		$5,447 90

Disbursements—

Printing Proceedings, advance sheets, notices, etc.	$1,235 09
Hotel, luncheon, music, etc.	649 73
Postage for Journals, etc.	259 40
Secretary's trip to Atlantic City	50 00
Cigars for meetings	101 25
Stereopticon light	10 00
Stationery and supplies	24 95
Messenger service	35 00
Secretaries' Association dues, year 1910-1911	15 00
Reporting Proceedings	135 00
Entertainment	148 00
Miscellaneous	5 22
Floral emblem	10 00
Salary Mr. J. D. Conway, year 1907-1908	500 00

Secretary's salary, year 1909-1910	500 00	
		$3,678 64
Balance in hands of Treasurer		$1,769 26

C. W. ALLEMAN,
Secretary.

Approved:
L. H. TURNER,
F. H. STARK,
D. J. REDDING,
Executive Committee.

TREASURER'S REPORT.

Pittsburgh, Pa., October 28th, 1910.

Receipts—		
Balance on hand from last year	$1,070 32	
Received from Secretary during year	4,377 58	
		$5,447 90
Expenditures—		
Paid out on Secretary's checks		$3,678 64
Balance on hand		$1,769 26

Respectfully submitted,
J. D. McILWAIN,
Treasurer.

Approved:
L. H. TURNER,
F. H. STARK,
D. J. REDDING,
Executive Committee.

PRESIDENT: We also have at this meeting the announcement of the result of the election of officers for the ensuing year. I will ask the Secretary to read the report.

Mr. President and Gentlemen:—In accordance with the Constitution and By-Laws of the Club, the ballots for the election of officers for the ensuing year were sent out by the Secretary in the usual way, and the returns made show that the officers as nominated at the September meeting were elected. The votes were counted this morning and there were a total of 303 votes cast. The names are as follow:

F. R. McFEATTERS, President.
WM. ELMER, First Vice President.
A. G. MITCHELL, Second Vice President.
J. D. McILWAIN, Treasurer.
C. W. ALLEMAN, Secretary.
L. H. TURNER, F. H. STARK, D. J. REDDING, Executive Committee.
D. C. NOBLE, STEPHEN C. MASON, C. E. POSTLETHWAITE, Finance Committee.
D. M. HOWE, C. A. LINDSTROM, A. L. HUMPHREY, M. A. MALLOY, G. P. SWEELEY, Membership Committee.

L. H. TURNER,
Chairman Executive Committee.

Pittsburgh, Pa., October 28th, 1910.

After the reading of the report the various officers were introduced and made short but appropriate responses, after which the president-elect, Mr. F. R. McFeatters, took the chair.

PRESIDENT McFEATTERS: We have a member present tonight who always insists upon making a speech; in fact, he asked me to call on him as soon as I got into office. Mr. Redding has sort of turned him down of late. Mr. Howe, will you kindly make your address?

MR. D. M. HOWE: First, I wish to congratulate our newly-installed President and wish him the same success as the gentleman just retiring from the chair has had. Sometimes we have a duty to perform which is more in the shape of a task. There are other times when duty is an extreme pleasure and the latter will apply to my brief talk this evening.

Our retiring President, Mr. David J. Redding, is one of the few charter members of this Club who has always been active in making it the success it has obtained. He was Vice President for two years and as we all know he served the same length of time as our President. As to the great success we have had during his official terms it has gone into the records making the history of our Club.

Mr. Redding, of genial disposition and stability of character, has endeared himself to one and all of us. It is, therefore, my pleasure to represent the membership of the Railway Club of Pittsburgh this evening in asking Mr. Redding to accept with our heartfelt greetings this most beautiful chest of silver. We hope, sir, you will accept it in the spirit in which it is given.

(At this point a large chest of table silver was brought in and placed before the speaker.)

MR. REDDING: Mr. President, Mr. Howe and Fellow Members:—I am not going to undertake to make a speech, but I am going to say that this is a surprise to me. I always had an idea when these things were being hatched up that the fellow who was going to receive the gift must necessarily know something about it. I did not think it possible for anything like this to be organized and carried out without some hint of it getting out. I did not have the slightest intimation that anything of this kind was going on; therefore, I am not prepared to say just what I would like to say in thanking you for it. I can only say that I certainly feel grateful that I have been able to serve this Club for two years as President. I have felt that the honor of serving the Club was alone sufficient reward for any work which it might involve. I can only say that I thank you from my heart out for this very beautiful present.

ON MOTION, Adjourned at 10:43 P. M.

The Railway Club of Pittsburgh Constitution.

ARTICLE I.

The name of this organization shall be "The Railway Club of Pittsburgh."

ARTICLE II.

OBJECTS.

The objects of this Club shall be mutual intercourse for the acquirement of knowledge, by reports and discussion, for the improvement of railway operation, construction, maintenance and equipment, and to bring into closer relationship men employed in railway work and kindred interests.

ARTICLE III.

MEMBERSHIP.

Section 1. The membership of this Club shall consist of persons interested in any department of railway service or kindred interests, or persons recommended by the Executive Committee upon the payment of the annual dues for the current year.

Sec. 2. Persons may become honorary members of this Club by a unanimous vote of all members present at any of its regular meetings, and shall be entitled to all the privileges of membership and not be subject to the payment of dues or assessments.

ARTICLE IV.

OFFICERS.

The officers of this Club shall consist of a President, First Vice President, Second Vice President, Secretary, Treasurer, Finance Committee consisting of three members, Membership Committee consisting of five members, and three Elective Executive Members who shall serve a term of one year from the date of their election unless a vacancy occurs, in which case a successor shall be elected to fill the unexpired term.

ARTICLE V.

DUTIES OF OFFICERS.

Sec. 1. The President will preside at all regular or special meetings of the Club and perform all duties pertaining to a presiding officer; also serve as a member of the Executive Committee.

Sec. 2. The First Vice President, in the absence of the President, will perform all the duties of that officer; the Second Vice President, in the absence of the President and First Vice President, will perform the duties of the presiding officer. The First and Second Vice Presidents shall also serve as members of the Executive Committee.

Sec. 3. The Secretary will attend all meetings of the Club or Executive Committee, keep full minutes of their proceedings, preserve the records and documents of the Club, accept and turn over all moneys received to the Treasurer at least once a month, draw cheques for all bills presented when approved by a majority of the Executive Committee present at any meetings of the Club, or Executive Committee meeting. He shall have charge of the publication of the Club Proceedings and perform other routine work pertaining to the business affairs of the Club under the direction of the Executive Committee.

Sec. 4. The Treasurer shall receipt for all moneys received from the Secretary, and deposit the same in the name of the Club within thirty days in a bank approved by the Executive Committee. All disbursements of the funds of the Club shall be by cheque signed by the Secretary and Treasurer.

Sec. 5. The Executive Committee will exercise a general supervision over the affairs of the Club and authorize all expenditures of its funds. The elective members of this Committee shall also perform the duties of an auditing committee to audit the accounts of the Club at the close of a term or at any time necessary to do so.

Sec. 6. The Finance Committee will have general supervision over the finances of the Club, and perform such duties as may be assigned them by the President or First and Second Vice Presidents.

Sec. 7. The Membership Committee will perform such duties as may be assigned them by the President or First and Second Vice Presidents, and such other duties as may be proper for such a committee.

ARTICLE VI.

ELECTION OF OFFICERS.

Sec. 1. The officers shall be elected at the regular annual meeting as follows, except as otherwise provided for:

Sec. 2. Written forms will be mailed to all the members of the Club, not less than twenty days previous to the annual meeting, by the three elective members of the Executive Committee. These forms shall provide a method, so that each member may express his choice for the several offices to be filled.

Sec. 3. The three elective members of the Executive Committee will present to the President the names of the members receiving the highest number of votes for each office, together with the number of votes received.

Sec. 4. The President will announce the result of the ballot and declare the election.

Sec. 5. Should two or more members receive the same number of votes, it shall be decided by a vote of the members present, by ballot.

ARTICLE VII.

AMENDMENTS.

Amendments may be made to this Constitution by written request of ten members, presented at a regular meeting and decided by a two-thirds vote of the members present at the next regular meeting.

BY-LAWS.

ARTICLE I.

MEETINGS.

Section 1. The regular meetings of the Club shall be held at Pittsburgh, Pa., on the fourth Friday of each month, except June, July and August, at 8:00 o'clock P. M.

Sec. 2. The annual meeting shall be held on the fourth Friday of October each year.

Sec. 3. The President may, at such times as he deems expedient, or upon request of a quorum, call special meetings.

ARTICLE II.

QUORUM.

At any regular or special meeting nine members shall constitute a quorum.

ARTICLE III.

DUES.

Sec. 1. The dues of members shall be $2.00 per annum, $1.00 of same to apply to subscription for Club Journal, payable in advance, on or before the fourth Friday of September each year.

Sec. 2. Each member will be assessed $1.00 etxra annually to provide light refreshments for each meeting.

Sec. 3. At the annual meeting members whose dues are unpaid shall be dropped from the roll after due notice mailed them at least thirty days previous.

Sec. 4. Members suspended for non-payment of dues shall not be reinstated until all arrearages have been paid.

ARTICLE IV.

ORDER OF BUSINESS.

1—Roll call.

2—Reading of the minutes.

3—Announcements of new members.
4—Reports of Committees.
5—Communications, notices, etc.
6—Unfinished business.
7—New business.
8—Recess.
9—Discussion of subjects presented at previous meeting.
10—Appointment of committees.
11—Election of officers.
12—Announcements.
13—Financial reports or statements.
14—Adjournment.

ARTICLE V.

SUBJECTS—PUBLICATIONS.

Sec. 1. The Executive Committee will provide the papers or matter for discussion at each regular meeting.

Sec. 2. The proceedings or such portion as the Executive Committee may approve shall be published (standard size, 6x9 inches), and mailed to the members of the Club or other similar clubs with which exchange is made.

ARTICLE VI.

The stenographic report of the meetings will be confined to resolutions, motions and discussions of papers unless otherwise directed by the presiding officer.

ARTICLE VII.

AMENDMENTS.

These By-Laws may be amended by written request of ten members, presented at a regular meeting, and a two-thirds vote of the members present at the next meeting.

MEMBERS.

Ackenheil, J. D.,
District Sales Agent,
The Patterson-Sargent Co.
1701 Arrott Building,
Pittsburgh, Pa.

Albree, Chester B.,
President and Chief Engineer,
Chester B. Albree Iron
Works Co.,
1115 Market St.,
N. S., Pittsburgh, Pa.

Alexander, J. R.,
Gen'l R. F. of E.,
Pennsylvania R. R. Co.,
Altoona, Pa.

Alleman, C. W.,
Chief Clerk to S. M. P.,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Allen, Harry L.,
Manager,
American Steel Foundries,
Alliance, Ohio.

Allen, Jas. P.,
Secretary,
Union Steel Castings Co.,
61st St. and A. V. Ry.,
Pittsburgh, Pa.

Allison, John,
Chief Engineer,
Pittsburgh Equipment Co.,
Glassport, Pa.

Altman, C. M.,
Asst. Foreman Car Insp.,
P. R. R. Co.,
R. F. D. No. 2,
Jeannette, Pa.

Amsbary, D. H.,
Manager, Dearborn Drug
& Chemical Co.,
Farmers Bank Building,
Pittsburgh, Pa.

Anderson, J. B.,
C. C. to S. M. P., P. R. R. Co.,
Union Station,
Pittsburgh, Pa.

Angell, C. P.,
Ass't. Train Master,
B. and O. R. R. Co.,
312 Winston St.,
Pittsburgh, Pa.

Armstrong, R. S.,
Mgr. Williams Disinfecting
Co.,
209 Seventh Street,
Pittsburgh, Pa.

Arensberg, F. L.,
Rep., McCullough-Dalzell
Crucible Co.,
36th St. and A. V. Ry.,
Pittsburgh, Pa.

Ashley, F. B.,
Purchasing Dept., Penna
Lines, West of Pgh.,
Union Station,
Pittsburgh, Pa.

Atterbury, W. W.,
Fifth Vice President,
Pennsylvania R. R. Co.,
Philadelphia, Pa.

Atwood, J. A.,
Chief Engineer,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Ayers, H. B.,
Gen. Mgr., H. K. Porter Co.,
49th St. and A. V. Ry.,
Pittsburgh, Pa.

Bailey, J. H.,
General Foreman,
56th St. Plant,
The McConway & Torley
Co.,
Pittsburgh, Pa.

Baird, F. C.,
G. F. A., B. & L. E. R. R.,
Frick Building,
Pittsburgh, Pa

Baker, B. R.,
Rep., Gulf Refining Co.,
Frick Building,
Pittsburgh, Pa.

Baker, Edwin H.,
Rep., Galena Signal Oil Co.,
26 Broadway,
New York, N. Y.

Baker, J. H.,
Clerk, M. P. Dept.,
P. R. R. Co.,
Union Station,
Pittsburgh, Pa.

Baker, Jas. H.,
Forging Engineer,
316 Fourth Ave.,
Pittsburgh, Pa.

Baldwin, Stephen Y.,
Com. Frt. Agent,
D. & H. Co., Bessemer Bldg.,
Pittsburgh, Pa.

Bali, Geo. L.,
Sec'y and Treas.,
Ball Chemical Co.,
153 East Ohio St.,
Millvale, Pa.

Bannister, E. J.,
Rep., Crucible Steel Co.
of America, 5621 Butler St.,
Pittsburgh, Pa.

Barth, John W.,
Rep., Sterling Steel
Foundry Co.,
Lemington Ave.,
12th Ward,
Pittsburgh, Pa.

Bartley, Milton,
President, American Nut &
Bolt Fastener Co.,
P. O. Box 996,
Pittsburgh, Pa.

Barwis, J. McC.,
Fore. Insp'r., P. R. R. Co.,
Union Station,
Pittsburgh, Pa.

Basford, G. M.,
Ass't to President,
American Loco. Co.,
30 Church St.,
New York, N. Y.

Bateman, Paul,
1126 Maple Place,
St. Louis, Mo.

Bealor, B. G.,
Vice Pres. and General
Manager,
Althom Sand Co.,
421 Wood St.,
Pittsburgh, Pa.

Beatty, E. A.,
Foreman, American
Locomotive Co.,
1429 Woodland Ave.,
N. S., Pittsburgh, Pa.

Beatty, E. G.,
Rep., Galena Signal Oil Co.,
Franklin, Pa.

Beatty, J. B.,
C. C., Car Shops,
Penna. R. R. Co.,
816 Sixth Ave.,
Pittsburgh, Pa.

Bell, Walter,
Inspector, P. R. R. Co.,
Penna. Lines Bldg.,
Pittsburgh, Pa.

Bellows, A. B.,
Manager, Pittsburgh
Testing Laboratory,
325 Water St.,
Pittsburgh, Pa.

Belsterling, C. S.,
Traffic Manager,
American Bridge Co.,
Frick Building,
Pittsburgh, Pa.

Beltz, John D.,
Engineer, B. & O. R. R. Co.,
219 Winston St.,
Pittsburgh, Pa.

Bengnot, J. J.,
General Foreman,
Pennsylvania Co.,
Alliance, Ohio.

Benner, Jacob W.,
C. E., Steam Power,
Carnegie Steel Co.,
Munhall, Pa.

Benner, Samuel A.,
Gen'l. Mgr. Sales,
Carnegie Steel Co.,
Carnegie Bldg.,
Pittsburgh, Pa.

Bennett, H. W.,
Clerk, Penna. R. R. Co.,
Union Station,
Pittsburgh, Pa

Bennett, R. G.,
Inspector, M. P. Dept.,
Penna. R. R. Co.,
32nd and Carson Sts.,
Pittsburgh, Pa.

Berg, Karl,
Draftsman, H. K. Porter Co.,
280 Fisk St.,
Pittsburgh, Pa.

Berghane, A. L.,
Inspector, Westinghouse Air
Brake Co.,
Pitcairn, Pa.

Bigelow, Harry T.,
Rep., Hale & Kilburn
Mfg. Co.,
Fisher Building,
Chicago, Ill

Bigham, Chas. G.,
Pass. Cond'r.,
P. C. C. & St. L. Ry.,
Room 107 Union Station.
Pittsburgh, Pa.

Bihler, L. C.,
Traffic Manager,
Carnegie Steel Co.,
Carnegie Bldg.,
Pittsburgh, Pa.

Binns, J. Y.,
Special Agent,
Monongahela R. R. Co.,
Brownsville, Pa.

Bishop, J. B.,
Resident Inspector,
B. & O. R. R. Co.,
Water Street,
Pittsburgh, Pa.

Bixler, H. C.,
Pennsylvania Tunnel and
Terminal R. R. Co.,
Pennsylvania Station,
7th Ave. and 32nd St..
New York, N. Y.

Black, Frank J.,
Assistant Superintendent
Carnegie Steel Co.,
Island Ave.,
McKees Rocks, Pa.

Blackall, Robt. H.,
Railway Supplies,
1315 Farmers Bank Bldg.,
Pittsburgh, Pa.

Blakely, T. M.,
R. F. of E., Penna. R. R.,
Penna. Lines Bldg.,
Pittsburgh, Pa.

Blest, M. C.,
Chief Draftsman,
Pressed Steel Car Co.,
80 Euclid Ave.,
Bellevue, Pa.

Bole, Robt. A.,
Manager, Manning, Maxwell
& Moore,
Park Building,
Pittsburgh, Pa.

Bolenius, H. C.,
Supervisor, Allegheny
Valley Railway,
Verona, Pa.

Booth, Arthur,
Ass't. Gen'l. Pur. Agent,
Philadelphia Co.,
435 Sixth Ave.,
Pittsburgh, Pa.

Booth, Henry,
Road Foreman of Engines,
D. & H. Co.,
5 Canaan Street,
Carbondale, Pa.

Booth, J. K.,
Genl. Fore., B. & L. E. R. R.,
Greenville, Pa.

Booth, Jas.,
Rep.. Midvale Steel Co.,
Oliver Building.
Pittsburgh, Pa.

Borland, W. P.,
Ass't. Treas. & Ass't. Sec'y.,
Rodman Chemical Co.,
East Pittsburgh, Pa.

Bostwick, W. A.,
Metallurgical Engineer,
Carnegie Steel Co.,
Pittsburgh, Pa.

Boyd, Henry W.,
Rep. W. Va. Fire Clay
Mfg. Co.,
1700 Buena Vista St.,
N. S., Pittsburgh, Pa.

Boyd, Oliver,
Ass't. P. A., Union Switch
& Signal Co.,
7926 Tioga St.
Pittsburgh, Pa

Boyer, Chas. E.,
Ass't. Gen'l. Car Inspector,
P. R. R. Co.,
Room 206, Union Station,
Union Station,
Pittsburgh, Pa.

Brady, Daniel M.,
President, Brady Brass Co.,
95 Liberty Street,
New York, N. Y.

Brand, Thos.,
Train Master,
Montour R. R. Co.,
Coraopolis, Pa.

Brandt, E. K.,
Ass't. Train Master,
Penn'a R. R.,
Union Station,
Pittsburgh, Pa.

Branson, Craig R.,
M. P. Inspector,
Pennsylvania Co.,
302 West Berry St.,
Fort Wayne, Ind.

Brewster, Morris B.,
Rep., U. S. Metallic Packing
Co., 6040 Jefferson Ave.,
Chicago, Ill.

Brower, R. M.,
Rep., American Brake Shoe
& Foundry Co.,
30 Church St.,
New York, N. Y.

Brown, Arthur A.,
Rep., Westinghouse,
Church, Kerr & Co.,
Union Bank Building,
Pittsburgh, Pa.

Brown, A. D.,
C. C. to Genl. Manager,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Brown, J. Alexander,
Vice Prest. & Gen. Mgr.,
Pocket List of R. R. Officials,
24 Park Place,
New York, N. Y.

Brown, John T.,
Vice Pres. and Genl. Manager,
Damascus Bronze Co.,
Allegheny, Pa.

Brown, John T., Jr.,
Supt. Duquesne Reduction Co.,
Farmers Bank Building,
Pittsburgh, Pa.

Brown, L. M.,
Salesman, McKenna Bros.,
253 Virginia Ave.,
Pittsburgh, Pa.

Brownscombe, G. J.,
Clerk, Union R. R. Co.,
209 Lobinger Ave.,
Braddock, Pa.

Brunker, A. R.,
General Sales Agent,
American Steel Foundries,
Chester, Pa.

Buchanan, E. G.,
Rep., Carbon Steel Co.,
30 Church St.,
New York, N. Y.

Bucher, C. A.,
Rep. Rich Tool Co.,
420 Pacific Ave.,
Pittsburgh, Pa.

Bugle, Geo.,
Traveling Engineer,
Penna. R. R. Co.,
346 Miller St.,
Mt. Oliver, Pittsburgh, Pa.

Buffington, W. P.,
C. C. to Supt. Trans.,
Pittsburgh Coal Co.,
Hussey Building,
Pittsburgh, Pa.

Bulkley, B. M.,
Rep., Greene, Tweed & Co.,
314 McKee Place,
Pittsburgh, Pa.

Bulkley, J. T.,
Rep., Jenkins Bros.,
300 N. Negley Ave.,
Pittsburgh, Pa.

Burgher, R.,
Pres't., Kidd Bros. & Burgher
Steel Wire Co.,
Aliquippa, Pa.

Burns, Robert C.,
Gen. A. B. and S. H.
Inspector, P. R. R. Co.,
1408 Eighth St.,
Altoona, Pa.

Burry, V. J.,
Drawing Instructor,
P. & L. E. R. R. Co.,
General Office,
Pittsburgh, Pa.

Butts, G. W.,
Ass't. Div. Operator
P. R. R. Co.,
Altoona, Pa.

Calvert, H. W.,
Round House Foreman,
P. & L. E. R. R.,
516 Marwood St.,
McKees Rocks, Pa.

Campbell, I. K.,
care County Commissioners' Office,
Pittsburgh, Pa.

Cardwell, J. R.,
Pres., Union Draft Gear Co.,
Monadnock Block,
Chicago, Ill.

Cargo, B. B.,
Master Mechanic,
Lake Terminal R. R.,
Lorain, Ohio.

Carson, G. E.,
Div. Master Car Builder,
N. Y. C. & H. R. R. R. Co.,
W. Albany, N. Y.

Carson, Robert, Jr.,
23 Terminal Way,
S. S., Pittsburgh, Pa.

Cassidy, D. E.,
Asst. M. M.,
P. R. R. Company,
1716 Middle St.,
Sharpsburg, Pa.

Chapin, E. S.,
Motive Power Inspector,
P. R. R. Co.,
1016 Lexington Ave.,
Altoona, Pa.

Chilcoat, H. E.,
Rep., Westinghouse Air
Brake Co.,
Westinghouse Building,
Pittsburgh, Pa.

Chislett, Wm. B.,
Pass. Condr., P. R. R. Co.,
Union Station,
Pittsburgh, Pa.

Chittenden, A. D.,
Ass't. to Genl. Manager,
B. & L. E. R. R.,
Carnegie Bldg.,
Pittsburgh, Pa.

Christiansen, A.,
Chief Engineer,
Standard Steel Car Co.,
Butler, Pa.

Chrysler, W. P.,
Ass't. Manager,
American Loco. Co.,
84 Sevelle Ave.,
Bellevue, Pa.

Clancy, J. R.,
1010 W. Belden Ave.,
Syracuse, N. Y.

Clark, C. C.,
Chief Clerk, Sales Dep't.,
Pressed Steel Car Co.,
Farmers Bank Bldg.,
Pittsburgh, Pa.

Clark, Chas. H.,
President, Clark Car Co.,
Frick Annex,
Pittsburgh, Pa.

Clark, R. A.,
President, The Interlocking
Nut and Bolt Co.,
Farmers Bank Building,
Pittsburgh, Pa.

Clarke, Robert C.,
Surgeon, P. & L. E. R. R.,
129 So. Highland Ave.,
Pittsburgh, Pa.

Cline, W. A.,
Asst. Supt. Transportation
and Labor,
Carnegie Steel Co.,
P. O. Box 507,
Munhall, Pa.

Coates, H. T., Jr.,
c. o. General Manager,
Penna R. R. Co.,
Broad Street Station,
Philadelphia, Pa.

Cochran, Chas. C.,
C. C. to Gen'l Manager,
Pressed Steel Car Co.,
McKees Rocks, Pa.

Coffin, J. S.,
Vice President,
American Brake Shoe
& Fdy. Co.,
30 Church St.,
New York City, N. Y.

Coffin, W. E.,
Rep. National Malleable
Castings Co.,
7706 Platt Ave.,
Cleveland, O.

Coho, O. C.,
Engine House Foreman,
Penna. R. R. Co.,
Youngwood, Pa.

Cole, Jewett,
Enginehouse Foreman,
P. R. R. Co.,
207 Union Station,
Pittsburgh, Pa.

Conneeley, E. K.,
Purchasing Agent,
P. & L. E. R. R. Co.,
Gen'l Office,
Pittsburgh, Pa.

Conway, J. D.,
Secretary, Railway Supply
Manufacturer's Association,
Oliver Building,
Pittsburgh, Pa.

Cook, Joseph A.,
Ass't. Train Master,
Penn'a R. R.,
2843 Broadway Ave.,
Dormont Boro., Pa.

Cooper, F. E.,
Manager, R. R. Dept.,
J. A. & W. Bird Co.,
31 Union Square, W.,
New York, N. Y.

Cordner, A. C.,
Representing Bemis & Call
Hardware & Tool Co.,
Springfield, Mass.

Condit, E. A., Jr.,
Rep., The Rail Joint Co.,
Oliver Building,
Pittsburgh, Pa.

Coulter, A. F.,
G. C. F., Union R. R. Co.,
Port Perry, Pa.

Courson, Chas. L.,
Fore. Car Inspectors,
P. R. R. Company,
Pitcairn, Pa.

Courson, J. F.,
General Foreman,
Pennsylvania R. R. Co.,
Pitcairn, Pa.

Courtney, D. C.,
1130 Sheffield St.,
Allegheny, Pa.

Cover, N. C.,
Chief Clerk to Gen. Foreman,
P. & L. E. R. R. Co.,
532 Hayman St.,
Youngstown, O.

Cox, P. L.,
Road Master,
Monon. Con. R. R.,
2nd Ave. near Bates St.,
Pittsburgh, Pa

Craig, E. A.,
South Eastern Manager,
Westinghouse Air Brake Co.,
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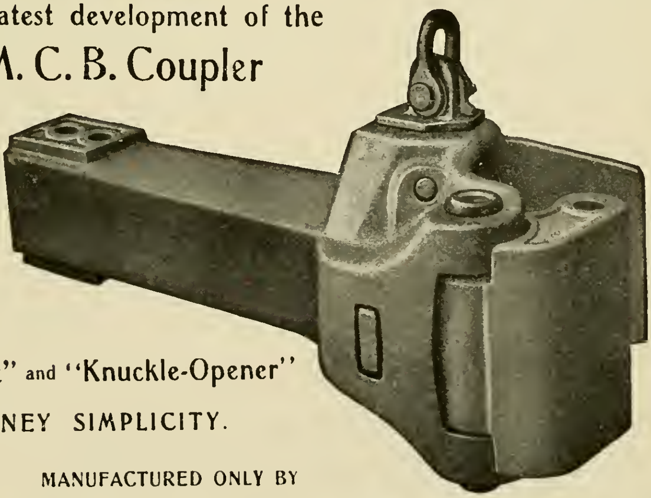

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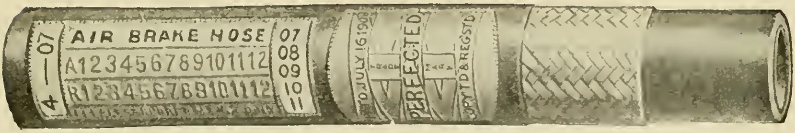

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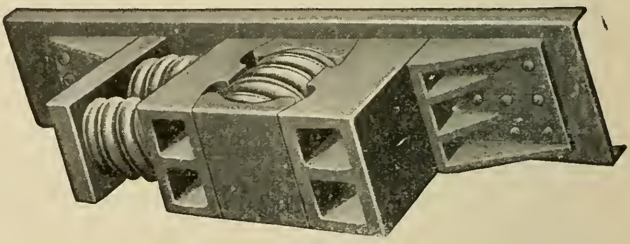

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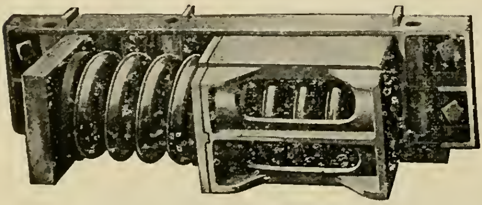

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